3.11 WETLANDS

This section summarizes the nature and extent of wetlands that would potentially be affected by the proposed mine site, the transportation facilities that would provide access and supply materials to the mine, and the natural gas pipeline that would supply energy for the mine. It also addresses the expected impacts of the project and alternatives on wetlands.

SYNOPSIS

This section describes current conditions and evaluates potential impacts to wetlands from the proposed action and alternatives. Each alternative is examined by major Project component: mine site; transportation facilities; and pipeline.

Summary of Existing Conditions:

Mine Site Wetlands Study Area: Eighty-one percent of the 63 mi^2 (40,491.2 acre) mine site study area is wetland, comprised predominately of evergreen forested and scrub shrub wetlands in flat or slope hydrogeomorphic classes and is a mosaic of wetland, upland, and transitional areas that have been influenced by recent and past wildland fires (3PPI et al. 2014). Rivers and streams within the mine site wetland study area total 183 miles with 73 percent of that being perennial streams and rivers (133 miles), and 27 percent being intermittent streams (50 miles) (3PPI et al. 2014).

Transportation Wetlands Study Area: Eighty-two percent of the 85 mi^2 (54,546.4 acre) transportation wetland study area is wetland; wetlands are predominately evergreen forested and scrub shrub wetlands in flat or slope hydrogeomorphic classes and this area is a mosaic of upland, wetland, and transitional areas (3PPI et al. 2014). Wetland distribution and extent are influenced by discontinuous permafrost. Rivers and streams within the mine transportation study area total 294 miles with 90 percent being perennial streams and rivers (263 miles), and 10 percent being intermittent streams (31 miles) (3PPI et al. 2014).

Pipeline Wetland Study Area: Forty-five percent of the 172 mi^2 (110,010.6 acre) pipeline wetland study area is wetlands. Wetlands throughout the pipeline route are predominately deciduous scrub shrub wetlands and evergreen forested and scrub shrub wetlands in flat or slope hydrogeomorphic classes. Rivers and streams within the pipeline route study corridor total 510 miles with 60 percent of these being perennial streams and rivers (307 miles), and 40 percent being intermittent streams (203 miles) (3PPI et al. 2014).

Expected Effects:

Alternative 1: No Action – This alternative would not have any new effects on wetland resources.

Alternative 2: Donlin Gold's Proposed Action – The anticipated direct and indirect effects on wetlands from all the components of Alternative 2 would be generally medium in intensity, long-term to permanent in duration, local to regional in extent, and common in context. The overall impact of the construction, operations, closure, and reclamation for Alternative 2 on wetlands would be considered moderate.

Other Alternatives: The effects of other alternatives on wetlands would be very similar to the effects of Alternative 2. Differences of note include:

- *Alternative 3A (LNG-Powered Haul Trucks)* – Reduced fuel barging could reduce potential wetland erosion from barge wakes, which would reduce the intensity to low under Alternative 3A for the transportation component.
- *Alternative 3B (Diesel Pipeline)* – Similar to Alternative 2; with an elimination of indirect effects from port expansions at Dutch Harbor, diesel storage at Angyaruaq (Jungjuk) Port, but with a new dock extension and diesel storage facility at Tyonek. Elimination of fuel barges under Alternative 3B reduces wetland erosion rates from barge wake energy to a low intensity. Alternative 3B pipeline construction impacts on wetlands would be medium in intensity similar to Alternative 2, although impacts would be increased by 227 acres of primarily deciduous scrub shrub wetlands (62 percent); in addition, the dock at Tyonek would also impact a small area of estuarine wetlands and waters. The diesel pipeline wetland impact duration, extent, and context would be similar to the Alternative 2 natural gas pipeline, although areas for access roads and airstrips would not be reclaimed prior to termination of pipeline operations.
- *Alternative 4 (Birch Tree Crossing Port)* – The longer port to mine road would affect more wetlands than Alternative 2. However, the overall direct and indirect effects of the construction and operations of Alternative 4 on wetlands would also be considered moderate.
- *Alternative 5A (Dry Stack Tailings)* – Dust from the Dry Stack Tailings may affect more area. There may be a potential for successful reestablishment of a larger area as wetlands after closure of the TSF/operating pond facilities, but the direct and indirect effects on wetlands would be similar to Alternative 2.
- *Alternative 6A (Dalzell Gorge Route)* – Alternative 6A would potentially affect more wetlands than the proposed Alternative 2 route. The overall direct and indirect effects of the construction, operations, closure, and reclamation of the natural gas pipeline route for Alternative 6A on wetlands would also be considered moderate.

3.11.1 REGULATORY FRAMEWORK

Wetlands are areas that are inundated or saturated by surface water or groundwater at a frequency and duration sufficient to support a prevalence of vegetation typically adapted for life in saturated soil conditions (33 Code of Federal Regulations [CFR] 328.3(b)). Wetlands support hydrophytic vegetation, have wetland hydrology, and contain hydric soils. Section 404 of the Clean Water Act (CWA; 33 USC 1344) and Section 10 of the Rivers and Harbors Act (RHA; 33 USC 403) establish programs to regulate the discharge of dredged or fill material into waters of the U.S., including wetlands. Jurisdictional wetlands, regulated through permitting by the U.S. Army Corps of Engineers (Corps) under Section 404, must possess wetland indicators for hydrology, vegetation, and soils. Section 404(b)(1) of the CWA requires that the Corps permit only the least environmentally damaging practicable alternative. Protection of wetlands during permit review focuses first on avoidance of impacts, followed by minimization of impacts, and finally requires compensatory mitigation for unavoidable impacts to wetlands and waters. Protection of wetlands is defined as the avoidance, to the extent possible, of the long- and short-term adverse impacts associated with the destruction or modification of wetlands and the avoidance of direct or indirect support of new construction in wetlands wherever there is a practicable alternative (Executive Order 11990).

Regulatory standards and criteria for the use of compensatory mitigation to offset unavoidable impacts to waters of the U.S., including wetlands, authorized under the CWA and the RHA, were established on April 10, 2008 under 33 CFR 332 (Corps) and 40 CFR Part 230 (U.S. Environmental Protection Agency [EPA]). Compensatory mitigation for unavoidable impacts may be required to ensure that activities requiring a 404 permit comply with Section 404(b)(1) Guidelines. Compensatory mitigation is the restoration (reestablishment or rehabilitation), establishment (creation), enhancement, and/or in certain circumstances preservation of aquatic resources to offset unavoidable adverse impacts. Compensatory mitigation may be achieved by purchasing credits through mitigation banks or in-lieu fee programs or by permittee-responsible mitigation, or by a combination of the three.

Donlin Gold has submitted a watershed-based draft Compensatory Mitigation Plan (CMP) in coordination with federal, state, and local governments and landowners. The CMP would consider the importance of landscape position and resource types to ensure the sustainability of aquatic resources and functions within each watershed. It would also consider how the types and locations of compensatory mitigation projects would provide the desired aquatic resource functions and values, and remain functional over time in a changing landscape. Considerations would include: (1) habitat requirement of important animals, (2) habitat loss or conversion trends, (3) sources of watershed impairment, (4) current development trends, and (5) requirements of other regulatory and non-regulatory programs that affect the watershed, such as stormwater management or habitat conservation. A watershed approach would consider the protection and maintenance of terrestrial resources, such as riparian areas and uplands, when those resources contribute to the overall ecological functioning of aquatic resources in the watershed. The CMP may include onsite mitigation, off-site mitigation (including mitigation banks and in-lieu fee programs), permittee-responsible mitigation, non-traditional mitigation, or a combination of approaches. The CMP would address compensation for both temporary and permanent losses of wetland functions resulting from the proposed Donlin Gold Mine Project. Mitigation would be considered throughout the NEPA and permitting processes. A final Section 404 CWA and Section 10 RHA permit application would be submitted prior to the issuance of the Corps' Record of Decision. Basic components of the proposed Project are not anticipated to change substantially, although the Project design and associated compensatory mitigation needs are likely to be refined based on engineering and field studies. Specific mitigation requirements would be made in conjunction with the final permit application review and NEPA process, after all affected stakeholder concerns have been considered (see Application Block 23 – Compensation; Section 404 CWA and Section 10 RHA Preliminary Permit Application, November 2014; 3PPI and Resource Data, 2014).

3.11.2 ANALYSIS METHODOLOGY

Wetlands in and around the EIS Analysis Area were mapped for Donlin Gold, LLC by 3PPI et al. (2012, 2014) based on the wetland criteria in the Corps' Wetland Delineation Manual (Corps 1987) in anticipation of preparation of a Section 404 permit application which requires delineation of wetlands necessary to support design of the Project to avoid and minimize impacts to wetlands and waters. Mapping was a multi-year effort that began in 1996 and continued through 2014 (3PPI et al. 2014). As regional supplements to the 1987 Manual became available (Corps 2006a, 2007), wetland data were collected consistent with these supplements, although wetland determination criteria remained consistent with the original manual (Corps 1987). Preparation of the Preliminary Jurisdictional Delineation (PJD) included four components: (1) evaluation of existing data, (2) field data collection, (3) aerial photo interpretation and mapping, and (4) database quality control (3PPI et al. 2014). Open water features were mapped at 1:400 scale (1 inch = 33 feet), and all other features were mapped at 1:1,200 scale (1 in = 100 ft) or 1:1,500 scale (1 in = 125 ft). Waters too narrow to be mapped as polygons (e.g., streams) were mapped as polylines (3PPI et al. 2014).

During mapping, four classification systems were assigned to each wetland polygon: (1) vegetation community classification based on the Alaska Vegetation Classification System (AVCS) (Viereck et al. 1992), (2) wetland determination reporting the relative percentage of wetland and uplands, (3) National Wetlands Inventory (NWI) classification (Cowardin et al. 1979), and (4) hydrogeomorphic (HGM) classification (Brinson 1993; Smith et al. 1995). Wetland mapping for the Donlin Gold Project assigned a jurisdictional class (JDWET) to polygons that were mapped as a mixture or mosaic of wetlands and uplands. The JDWET classes assigned levels of wetland or upland inclusions that range from wetland polygons with less than 1 percent upland inclusions to wetland mosaics with up to 10, 20 or 40 percent upland inclusions and upland polygons with less than 1 percent wetland inclusions to upland mosaics with up to 10, 20 or 40 percent wetland inclusions. For the purposes of analysis for this DEIS all wetland and upland mosaics were considered to be entirely wetland. This will over-estimate the amount of wetland impact. The JDWET classes would be revised during the Corps permit process to eliminate potential jurisdictional inconsistencies, and to determine adjusted areas of jurisdictional wetland impacts following recent jurisdictional guidelines.

Wetland classification systems carried forward in this analysis include the NWI classification for wetland type and HGM classification for wetland functions and functional ratings (3PPI 2014b; 3PPI et al. 2014). Descriptions of the wetland affected environment for the three project components – mine site, mine transportation, and pipeline – use subsets of the wetland mapping (3PPI et al. 2014) to quantify the affected environment within defined wetland study areas surrounding the proposed mine site, mine transportation facilities, and the pipeline.

Mine Site Wetland Study Area. The mine site wetland study area includes wetlands mapped within the Crooked Creek drainage in subbasins that contain either proposed mine infrastructure or Crooked Creek. These Crooked Creek subbasins were combined and then buffered by 1,000 feet to capture the ridges surrounding the combined subbasins to create the mine site wetland study area. Most of this mine site study area, including areas for all proposed Project footprints, has been delineated for wetlands (3PPI et al. 2014).

Transportation Wetland Study Areas. Transportation wetland study areas were evaluated along the roads and ports to access the mine site, along the barge route on the Kuskokwim River, and at port facilities in Bethel.

- *Mine Transportation Wetland Study Area*. The mine transportation wetland study area includes areas within 0.5 mile of the proposed and alternative mine site access road, airstrip, material sites, and port site. Most of the proposed and alternative roads, material sites, and port facilities, including all proposed footprint areas, have been mapped for wetlands (3PPI et al. 2014). Wetland functional assessment data has not been collected for the Birch Tree Crossing (BTC) road and port alternative (3PPI 2014b). This data will be collected if the alternative is carried forward for analysis in the Final EIS.
- *Kuskokwim River Wetland Study Area*. Detailed wetland mapping has not been completed for the barge route along the Kuskokwim River. Land cover data (Homer et al. 2004) were used to describe wetlands within an approximated Kuskokwim River floodplain for the Kuskokwim River study area, and NWI data (FWS 2014a) were used to evaluate shoreline erosion along segments of the river.
- *Bethel Wetland Study Area.* An area was evaluated around the Bethel Port to describe any potential impacts to wetlands from expansion at this facility to support equipment, cargo, and fuel storage and transfer. Detailed wetland mapping was not available. Wetland information was evaluated based on a Section 404 CWA permit application and statewide vegetation mapping (Boggs et al. 2012).

Pipeline Wetland Study Area. The pipeline wetland study area includes wetlands within 1,000 feet on either side of the proposed and alternative alignments; and within 500 feet around proposed and alternative camp locations, airstrips, temporary work spaces, and access roads. The proposed pipeline route and an alternative route through Dalzell Gorge have been mapped for wetlands (3PPI et al 2014).

3.11.2.1 WETLAND CATEGORIES

NWI classes and subclasses found within the EIS Analysis Area (Appendix K, Table K-1) were combined into general groups based on vegetation type and structure (Table 3.11-1; 3PPI et al. 2012, 3PPI et al. 2014). Evergreen forested and scrub shrub wetlands are predominant in the region around the proposed Donlin Gold mine, with a shift toward evergreen forested and deciduous scrub shrub wetlands in the pipeline corridor (Table 3.11-1). Evergreen forested and scrub shrub wetlands are primarily black spruce wetlands that contain varying degrees of canopy cover (closed, open, woodland) and canopy heights ranging from trees (≥ 20 feet) to shrubs (< 20 feet) where black spruce are stunted (Post 1996; 3PPI et al. 2014). Bog and fen wetlands are generally a mixture of deciduous scrub shrub and herbaceous wetlands within the deciduous scrub shrub category (3PPI et al. 2014). Bogs and fens occur within the pipeline wetland study area (3PPI et al. 2014).

Table 3.11-1: Wetland Categories for Mine Site, Mine Transportation, Kuskokwim River, Bethel, and Pipeline Wetland Study Areas

Wetland Category	NWI Class	NWI Description	Study Area Relative Abundance[1]				
			M	T	K	B	P
Evergreen Forested Wetlands	PFO4	Forested, Needle-leaved Evergreen	A	A	+	uk	A
Deciduous Forested Wetlands	PFO1	Forested, Broad-leaved Deciduous	-	-	+	uk	+
Mixed Forested Wetlands	PFO1/4	Forested, Broad-leaved Deciduous/ Needle-leaved Evergreen	+	+	+	uk	+
Evergreen Scrub Shrub Wetlands	PSS4	Scrub Shrub, Needle-leaved Evergreen	A	A	+	+	+
Deciduous Scrub Shrub Wetlands	PSS1	Scrub Shrub, Broad-leaved Deciduous	+	A	+	+	A
Herbaceous Wetlands	PEM1	Emergent, Persistent	+	+	+	+	+
Ponds	PUB	Unconsolidated Bottom	-	-	+	+	+
Lakes	L1, L2	Limnetic, Littoral	np	np	np	uk	-
Rivers	R1, R2, R3, R4	Tidal, Lower Perennial, Upper Perennial, Intermittent	+	+	+	+	+

Notes:

1 Relative abundance of Wetland Category within mapped portion of Study Area.
A = abundant (≥ 20% by area)
B = Bethel Wetland Study Area (proportions unknown, presence only)
K = Kuskokwim River Wetland Study Area
M = Mine Site Wetland Study Area
P = Pipeline Wetland Study Area
T = Mine Transportation Wetland Study Area
+ = present (1 to 19% by area)
- = trace (<1% by area)
np = not present
uk = unknown

Source: Homer et al. 2004; Boggs et al. 2012; 3PPI et al. 2014.

3.11.2.2 HYDROGEOMORPHIC CLASSES AND WETLAND FUNCTIONS

Wetlands provide services or functions that are considered valuable to society (EPA 2001a). Wetlands were classified by HGM classes to evaluate their functions (3PPI 2014b; 3PPI et al. 2014). HGM classes include: depression, slope, flat, riverine, riverine (river) channel, lacustrine, and lacustrine (lake) fringe types based on landscape position, dominant water source, and hydrology (Table 3.11-2; 3PPI et al. 2014). Five of the seven HGM classes were preliminarily evaluated for eight wetland functions: (1) modification of groundwater discharge, (2) modification of groundwater recharge, (3) storm and floodwater storage, (4) modification of stream flow, (5) modification of water quality, (6) export of detritus, (7) contribution to abundance and diversity of wetland flora, and (8) contribution to abundance and diversity of wetland fauna. The functions of other types of waters that fall under Corps jurisdiction like river channels, lakes, and ponds were not evaluated. The preliminary results of functions performed by five of the seven HGM classes throughout the EIS Analysis Area are presented in Table 3.11-3.

Functions of wetlands within the study areas were preliminarily assessed using a variation of the Magee and Holland's rapid functional assessment method (Magee and Hollands 1998). A model developed by 3PPI was the basis for developing functional capacity indices (FCIs) for the purpose of rating the functional performance and value for each of the five HGM classes evaluated (3PPI 2014b). The variables, assumptions, and calculations used to develop FCIs for each function and HGM class are described in the Donlin Gold wetland functional assessment (3PPI 2014b). The Corps has determined that the Corps will complete a functional assessment for the proposed project at or after the FEIS stage or the NEPA process.

3.11.2.3 WETLAND VALUES

All wetlands are not considered of equal value or conservation concern. Wetlands that are considered high value are those that: provide habitat for threatened or endangered species; are rare and high quality within a given region; provide habitat for very sensitive or important wildlife or plants; or are undisturbed and that are difficult or impossible to replace within a lifetime such as mature productive forested wetlands and certain bogs and fens with their unique plant communities that may take centuries to develop. The position and function of these high value wetlands in the landscape plays an integral role in overall watershed health. Within the EIS Analysis Area wetlands surrounding and supporting hydrology of perennial streams used by anadromous fish are of conservation concern and value, especially streams used by salmon for spawning. Willow scrub shrub wetlands, often found near streams and ponds, are considered relatively rare and valuable for wildlife for forage, cover, and nesting. 3PPI completed a functional assessment for wetlands that preliminarily identifies high-functioning wetlands to assist with avoidance and minimization of impacts to high value wetlands, and to identify wetland functions that would be lost from unavoidable impacts for use in developing compensatory mitigation in consultation with the Corps (3PPI 2014b). These preliminary functional assessment results are described in the following sections for wetland study areas. The Corps has determined that the Corps will complete a functional assessment for the proposed project at or after the FEIS stage or the NEPA process.

3.11.2.4 IMPACT ASSESSMENT BOUNDARIES

Quantitative impacts to wetlands in the discussion of environmental consequences were assessed based on the spatial overlay of proposed and alternative project footprints on wetland delineation maps containing functional assessment attributes (3PPI 2014b; 3PPI and et al. 2014). The wetland delineation dataset used to preliminarily determine acreage of wetland impacts was available as polygons labeled as wetlands, uplands, or mosaics with various levels of upland inclusions (ranging from 10 to 20, 40, 60, 80, or 90 percent uplands). For the DEIS analysis, all wetland/upland mosaic polygons were treated as 100 percent wetlands, and polygon quantities are reported in acres. Waters, including intermittent and perennial streams, too small to be mapped as polygons were mapped as polylines; these are reported in miles (3PPI et al. 2014). Both quantities are provided in summary tables.

Table 3.11-2: Hydrogeomorphic (HGM) Class Descriptions for Donlin Gold Mine Project Wetlands

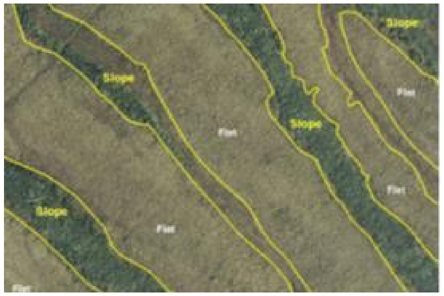
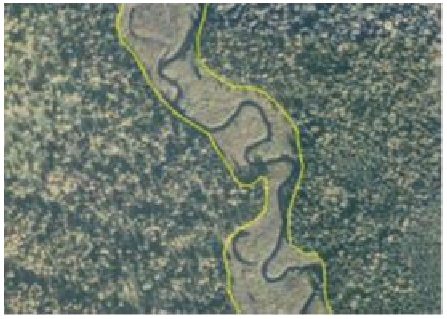
HGM Class Description	Examples	
Depressional (Depression) Wetlands occur in topographic depressions (closed elevation contours). The direction of water flow from surrounding areas is toward the center of the depression where surface waters accumulate. Water sources include precipitation, groundwater discharge, and surface flow often with seasonal vertical fluctuations. Water loss is through intermittent or perennial outflow, evapotranspiration or seepage to groundwater. In the EIS Analysis Area, depressional wetlands occur as abandoned river features on terraces (oxbows) above active floodplains or as kettles on moraine landforms. Depressional wetlands are often embedded within other HGM wetland classes.	 Depressional wetland in abandoned channel on terrace Crooked Creek floodplain	 Depressional wetlands, Cook Inlet Basin Ecoregion
Flat Wetlands occur where shallow permafrost tables perch precipitation at or near the surface on ridgetops, hillsides, or broad glacial outwash terraces in valley bottoms. Surface flow is low and lateral. Water source is primarily precipitation with water loss from evapotranspiration, overland flow, and seepage to groundwater. In the EIS Analysis Area, flat wetlands may occur on either mineral soil or accreted organic matter similar to extensive peatlands. Flat wetlands are common within the EIS Analysis Area and are often closely associated with slope wetlands.	 Flat wetland on a hillside	 Flat bordered by slope wetland drainways
Slope Wetlands occur on sloping land from steep hillslopes to nearly level terrain. Surface flow is downslope. Water sources are primarily groundwater discharge, surface flow from surrounding areas, and precipitation; with water loss by subsurface and surface outflow and evapotranspiration. Slope wetlands in the EIS Analysis Area commonly occur as seeps on footslopes and as drainage ways in steep to rolling terrain where stream channels have not yet formed. Slope wetlands also occur as fens and string bogs in the EIS Analysis Area.	 Slope wetland as a high gradient drainway	 Slope wetland as a string bog, Cook Inlet Basin ecoregion

Table 3.11-2: Hydrogeomorphic (HGM) Class Descriptions for Donlin Gold Mine Project Wetlands

HGM Class Description	Examples	
Riverine Wetlands occur in active flood plains and riparian corridors associated with stream channels. Water sources are overbank flow from the channel and subsurface hyporheic flow; but may also include groundwater discharge and overland flow from adjacent uplands, tributaries and precipitation. Water loss is through flow returning to the channel, subsurface discharge to the channel, seepage to groundwater, and evapotranspiration. Riverine wetlands range from broad floodplains along large meandering rivers to narrow zones along higher gradient rivers and streams. Riverine wetlands are often modified by beaver activity. **Riverine (River) Channel** wetlands and waters occur within the active channel of an intermittent or perennial stream or river. Water source and loss are the same as riverine wetlands This class includes vegetated or bare sand and gravel bars and channel areas with water or aquatic vegetation.	 Riverine wetlands bordering Shell Creek	 Riverine channel, Field Plot 3PP13967
Lacustrine includes the water in lakes that are greater than 20 acres in size or at least 6.6 feet deep. Water sources are precipitation, surrounding wetlands, and groundwater. Water loss may be through an outflow, evapotranspiration, or seepage into groundwater. **Lacustrine (Lake) Fringe Wetlands** occur next to lakes which maintain the water table in these wetlands. Surface flow is bi-directional. Water sources are precipitation and groundwater discharge. Water loss is through flow returning to the lake and by evapotranspiration. Lacustrine and lake fringe classes occur at Charlie Lake, Rainy Pass Lake and at other lakes between Rainy Pass and the Skwentna River in the eastern portion of the EIS Analysis Area.	 Lacustrine and lacustrine (lake) fringe wetlands at Charlie Lake	

Sources: 3PPI et al. 2012.

Table 3.11-3: Preliminary Wetland Functions by HGM Class for Donlin Gold Mine Project Wetlands

Function	Depression	Flat	Slope	Riverine	Lake Fringe
Modification of Groundwater Discharge	Yes	Yes	Yes	Yes	No
Modification of Groundwater Recharge	Yes	Yes	No	Yes	Yes
Storm and Floodwater Storage	Yes	Yes	Yes	Yes	Yes
Modification of Stream Flow	Yes	Yes	Yes	Yes	Yes
Modification of Water Quality	Yes	Yes	Yes	Yes	Yes
Export of Detritus	Yes	Yes	Yes	Yes	Yes
Contribute to Abundance and Diversity of Wetland Flora	Yes	Yes	Yes	Yes	Yes
Contribute to Abundance and Diversity of Wetland Fauna	Yes	Yes	Yes	Yes	Yes

Source: 3PPI et al. 2012, 3PPI 2014b.

Footprints were used to quantify the wetland area potentially directly lost or altered by the project. Footprints were available for all proposed and alternative mine impact areas. Where linear features did not contain footprint information, assumptions were made that included: 150-foot wide construction ROW for the pipeline, 50- or 51-foot wide operational ROW for the pipeline, 30-foot wide transmission line construction and operational ROW, and 24-foot wide construction access roads. Wetland areas permanently or temporarily affected by the project and previous wetland areas that would be available for reclamation over the life of the project were quantified where these were identified within the footprint data (3PPI et al. 2014).

Potential indirect effects on wetlands that were analyzed in the consequences include:

1. areas of altered groundwater hydrology within the modeled maximum draw down groundwater surface due to the excavated and dewatered pit that could potentially alter wetland status, or function (ADEC 1999; BGC 2015b);
2. areas where wetland restoration may be delayed or unsuccessful due to permafrost degradation (ADEC 1999);
3. areas within 328 feet (100 m) of the mine access road and airstrip where air-borne dust, snow removal, snow drifting, and interruption of surface water sheet flow may potentially alter wetland status, productivity, and community composition (Walker and Everett 1987; Auerbach et al. 1997; Hasselbach et al. 2005); and
4. areas where barge wake energy may cause increased Kuskokwim River shoreline erosion effects based on NWI from circa 1980s imagery (FWS 2014a), deposition and erosion areas identified by shoreline changes between 1988 and 2006 (ARCADIS 2007a), and projected increases in seasonal wave energy (BGC 2007c).

3.11.3 AFFECTED ENVIRONMENT

An estimated 43 percent of Alaska's surface area is wetlands (Hall et al. 1994). Proposed project activities that range from barging through the Kuskokwim River delta to the origin of the natural gas pipeline in Cook Inlet would encompass three physical subdivisions of Alaska – Arctic and Western Alaska, Interior Alaska, and Southern Alaska (Hall et al. 1994). The wetland study areas developed and used for comparative purposes represent about 0.1 percent of the surface and wetland areas within the ecoregions that would be crossed by the project (Hall et al. 1994) (Table 3.11-4). As a result, direct and indirect impacts to wetlands described in the environmental consequences would then affect even smaller percentages of wetlands within these ecoregions. The proportion of wetlands within these wetland study areas ranges both above and below the ecoregion and division wetland proportions (Table 3.11-4). The largest differences are for the pipeline wetland study area through the Alaska Range Ecoregion where a higher proportion of the study area is wetlands, and through the Kuskokwim Mountains Ecoregion where a lower proportion of the study area is wetlands. These differences may indicate that the long narrow pipeline wetland study area may not accurately reflect the regional abundance of wetlands.

Table 3.11-4: Physical Subdivisions, Ecoregion, and Study Area Wetland Comparisons

Physical Subdivisions/Ecoregions/ Study Areas	Wetland (1,000 acres)	Total (1,000 acres)	Wetland[1] (%)
Southern Alaska Subdivision	9,051.2	69,718.6	13%
Cook Inlet Ecoregion	2,644.5	9,442.0	28%
Pipeline Wetland Study Area	13.2	32.1	41%
Interior Alaska Subdivision	70,665.7	160,701.1	44%
Alaska Range Ecoregion	1,339.5	18,197.4	7%
Pipeline Wetland Study Area	11.6	32.6	36%
Tanana – Kuskokwim Lowlands Ecoregion	8,256.1	13,550.9	61%
Pipeline Wetland Study Area	14.7	17.4	84%
Kuskokwim Mountains Ecoregion	24,462.4	44,182.5	55%
Pipeline Wetland Study Area	10.0	27.9	36%
Mine Site Wetland Study Area	32.9	40.5	81%
Mine Transportation Wetland Study Area[2]	44.9	54.5	82%

Notes:

1 Proportion of wetlands with subdivision, ecoregion, or wetland study area by ecoregion. Note that mosaic classes calculated as 100% wetlands overestimates the wetland area proportion.

2 The mine transportation wetland study area includes only the access roads and ports; the Kuskokwim River barge route is not included.

Source: 3PPI et al. 2014, adapted from Hall et al. 1994; Nowacki et al. 2001.

3.11.3.1 MINE SITE WETLAND STUDY AREA

Eighty-one percent of the proposed mine site study area is wetland (including mosaics), comprised predominately of evergreen forested and scrub shrub wetlands in flat or slope geomorphic settings (Table 3.11-5, Figure 3.11-1). This area is a mosaic of wetland, upland, and transitional areas that have been influenced by recent and past wildland fires (3PPI et al. 2014). Wetland distribution and extent are influenced by discontinuous permafrost; which prevents infiltration of surface waters and maintains saturated ground, especially on north-facing hillsides and toe slopes (Figure 3.11-1, Post 1996). Permafrost maintained wetlands may be converted to non-wetlands following fires that remove the insulating organic mat that protects permafrost from receding and creating better drainage conditions (Post 1996). Wetland conditions may return over the span of 40 to 60 years or more as the insulating organic mat recovers allowing the permafrost to reestablish to shallower depths (Post 1996). Common wetland communities within the mine site wetland study area include: black spruce forested wetlands on north-facing hillsides and toe slopes; willow-dominated shrub wetlands in creek drainages; moist tundra dominated by tussock cotton grass typically underlain by permafrost on hillsides, toe slopes, or valley bottoms; and shrub bogs and sedge marshes in valley bottoms (Figure 3.11-2; ARCADIS 2013a).

Rivers and streams within the mine site wetland study area total 183 miles with 73 percent perennial streams and rivers (133 miles), and 27 percent intermittent streams (50 miles) (Table 3.11-5; 3PPI et al. 2014).

Previous disturbances to wetlands and uplands within the proposed mine site area have been caused by a variety of current human activities including: ongoing placer mining; Donlin Gold's exploration drill roads and pads, all-terrain vehicle trails, roads; as well as historic human activities such as winter trails and the Crooked Creek village site (Figure 3.11-3). There have also been natural causes, such as landslides (3PPI et al. 2014). Drill roads and pads and placer mining account for 82 percent of the existing disturbances to wetlands and 50 percent of disturbance to uplands in the mine site study area (3PPI et al. 2014; Figure 3.11-4). Previously disturbed wetland habitats represent disproportionate amounts of deciduous scrub shrub and herbaceous wetlands (Figure 3.11-5), potentially in response to post-disturbance revegetation or succession.

Table 3.11-5: Mine Site Wetland Study Area Preliminary Calculation of Wetland Categories by HGM Classes

Wetland Category	HGM Class (acres)					Area (acres)	Area[1] (%)
	Depression	Flat	Slope	Riverine	River Channel		
Evergreen Forested Wetlands	0.1	15,219.7	1,786.8	531.3	0	17,537.9	43%
Deciduous Forested Wetlands	0	88.8	14.3	131.9	0	235.0	1%
Mixed Forested Wetlands	0.9	155.5	1,067.1	886.8	0	2,110.4	5%
Evergreen Scrub Shrub Wetlands	2.1	6,245.2	1,612.0	46.4	0	7,905.7	20%
Deciduous Scrub Shrub Wetlands	11.7	3,120.6	1,093.2	487.4	0	4,713.1	12%
Herbaceous Wetlands	58.1	31.9	223.7	100.2	0	413.8	1%
Ponds	4.6	0	0	30.3	0.9	35.8	<1%
Lakes	0	0	0	0	0	0	NA

Table 3.11-5: Mine Site Wetland Study Area Preliminary Calculation of Wetland Categories by HGM Classes

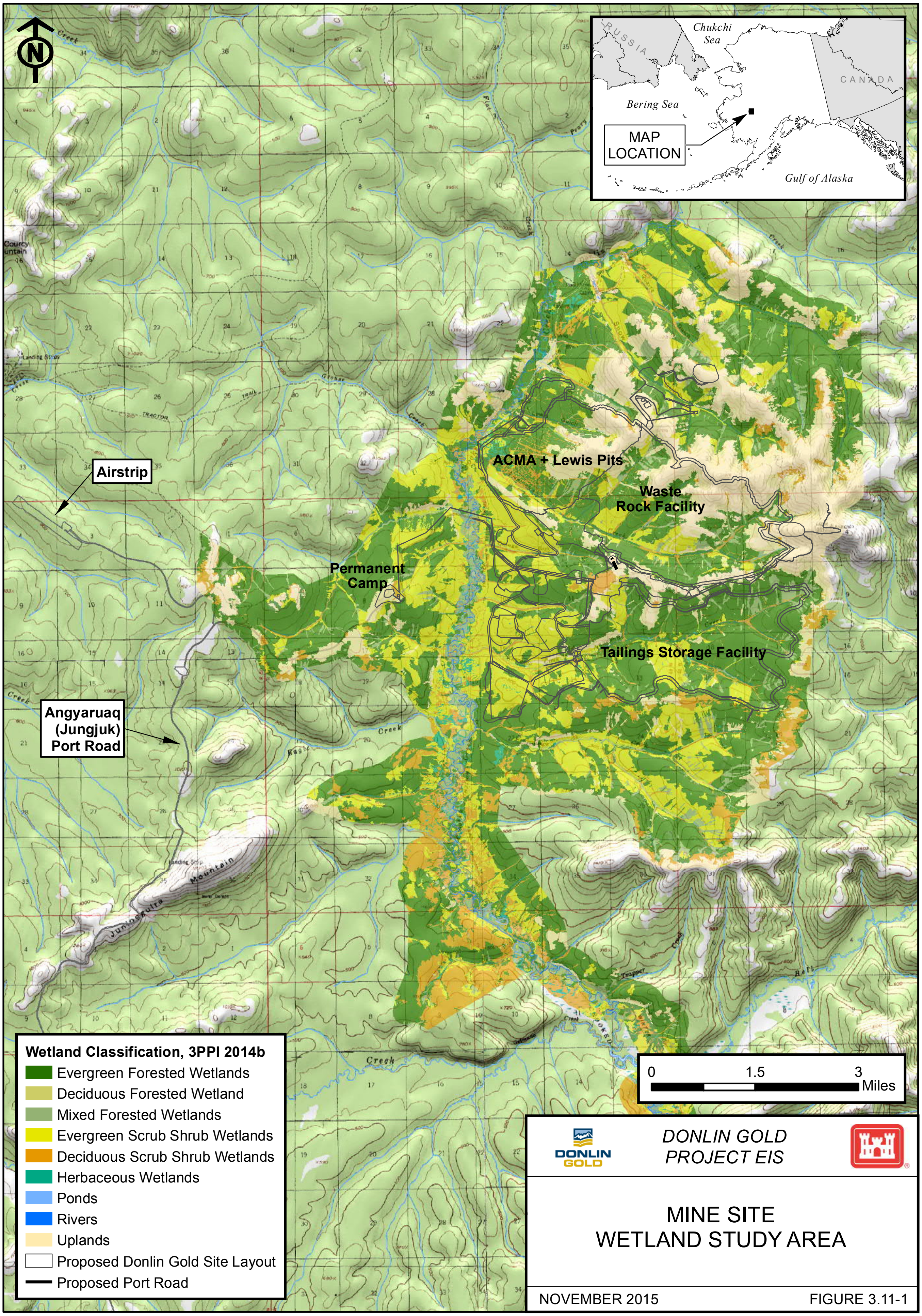
Wetland Category	HGM Class (acres)					Area (acres)	Area[1] (%)
	Depression	Flat	Slope	Riverine	River Channel		
Rivers	0	0	0	0	317.0	317.0	1%
Intermittent Streams (miles)	NA	NA	NA	NA	NA	49.9	27%
Perennial Streams (miles)	NA	NA	NA	NA	NA	133.2	73%
Uplands	NA	NA	NA	NA	NA	7,222.6	18%
Area (acre)	77.6	24,861.7	5,797.1	2,214.4	317.9	40,491.2	NA
Wetland Area (%, acre)	<1%	75%	17%	7%	1%	32,915.9	82%

Notes:

1 Proportion of total study area by wetland category. Note that mosaic classes calculated as 100% wetlands overestimate the wetland area proportion.

NA = Not Applicable 0 = None 0.0 = < 0.1

Source: 3PPI et al.2014.



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MINE SITE
WETLAND STUDY AREA

NOVEMBER 2015

FIGURE 3.11-1

Evergreen Forested Wetland, PF04B, Closed Black Spruce Forest, American Creek Watershed

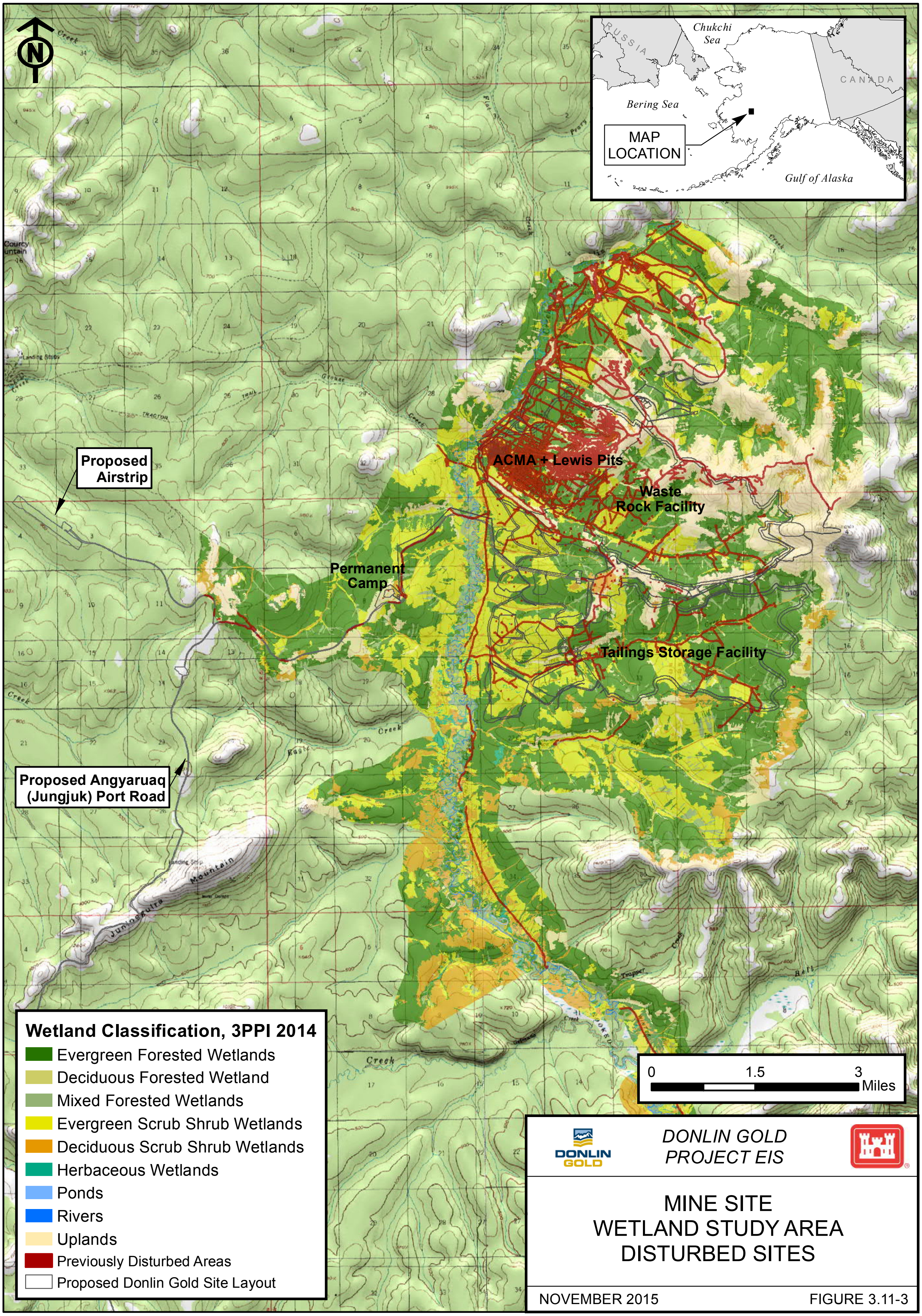
Evergreen Scrub Shrub Wetland, PSS4B, Open Black Spruce Forest-Shrub, Crooked Creek Watershed

Deciduous Scrub Shrub Wetland, PSS1C, Open Alder Willow Shrub, American Creek Watershed

Herbaceous Wetland, PEM1C, Emergent Aquatic, Crooked Creek Watershed

Source: 3PPI et al. 2012; 3PPI 2014a

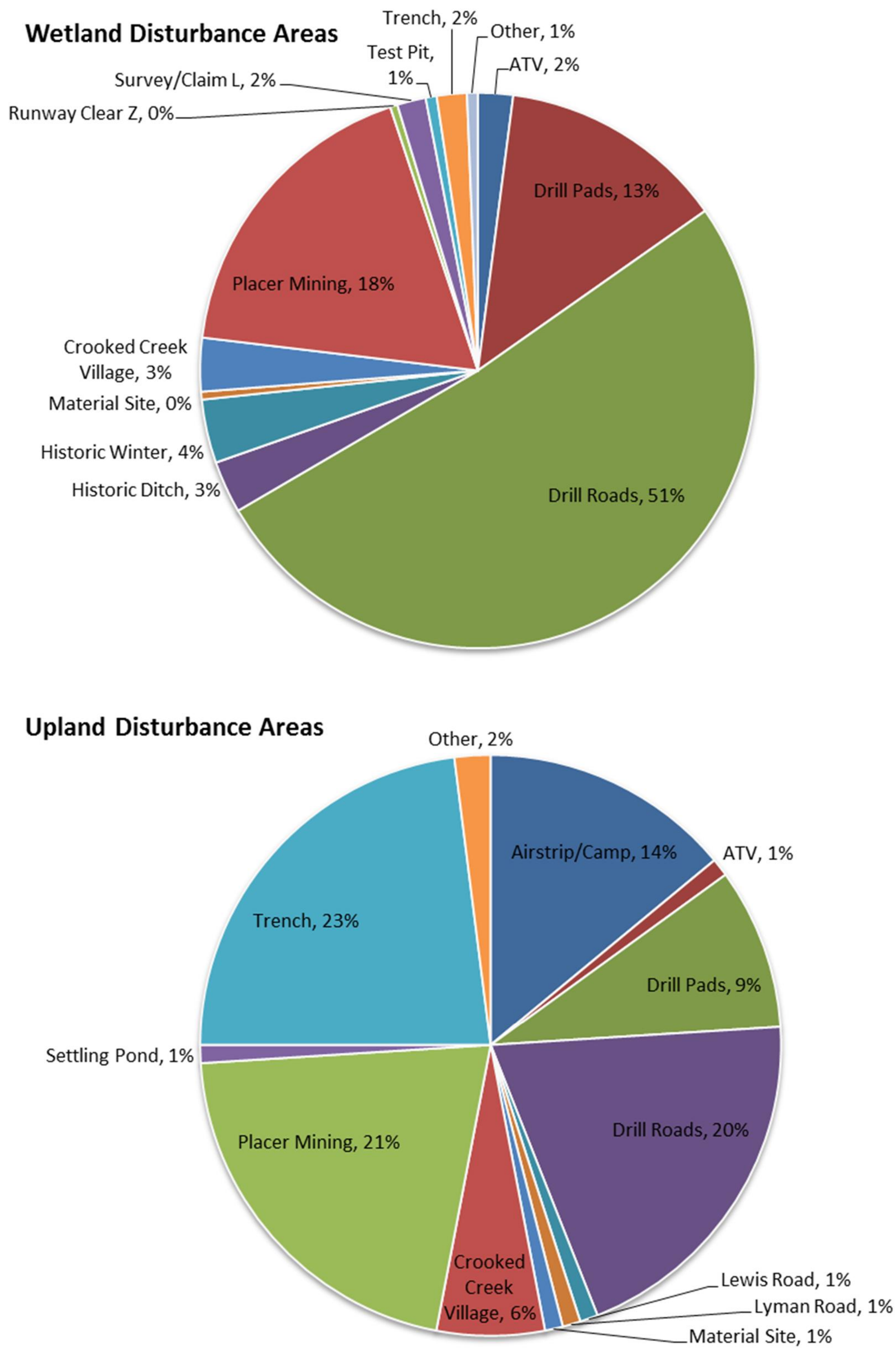
Figure 3.11-2: Common Wetland Types in the Mine Site Wetland Study Area



MINE SITE
WETLAND STUDY AREA
DISTURBED SITES

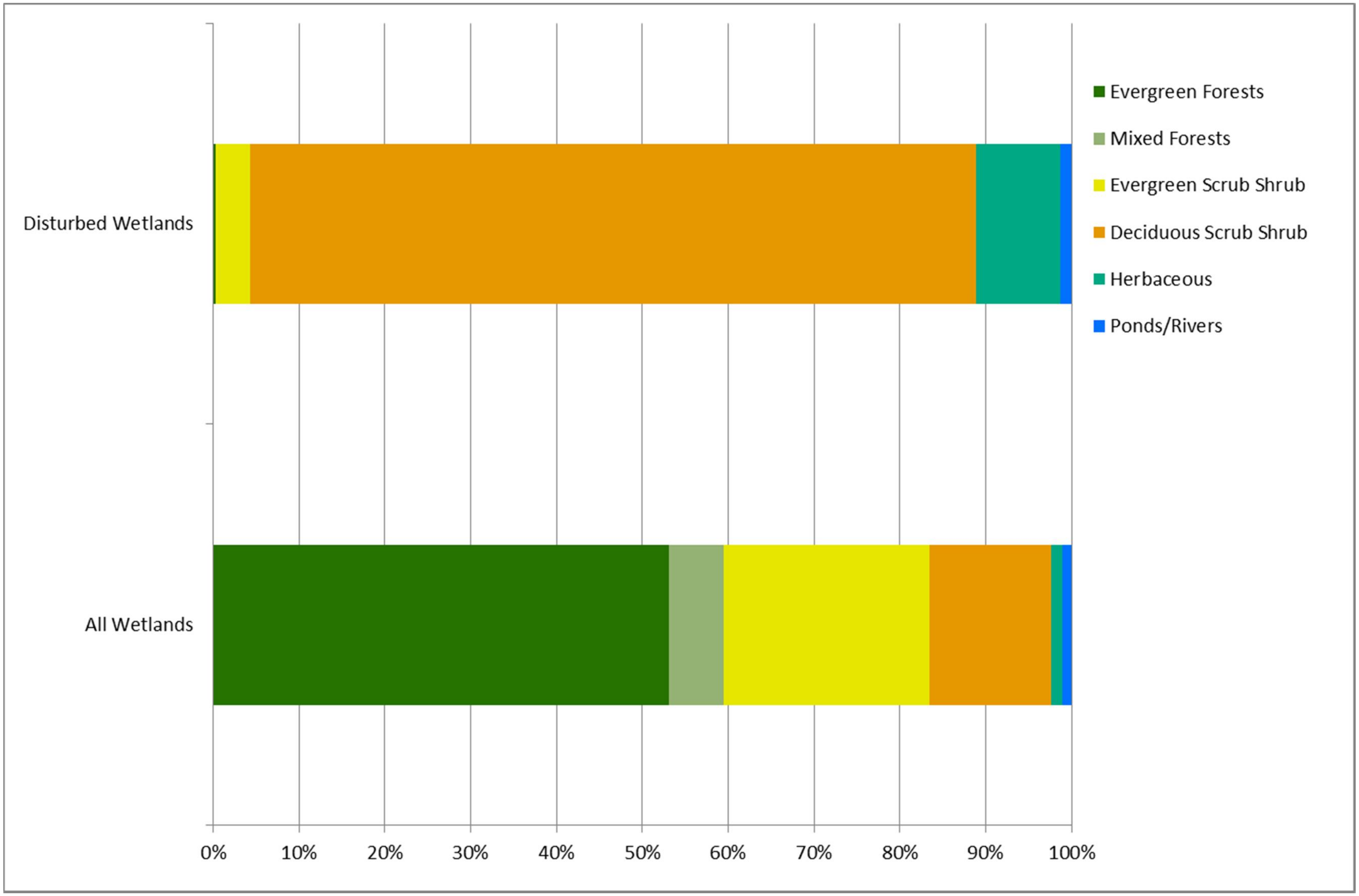
NOVEMBER 2015

FIGURE 3.11-3



Source: 3PPI et al. 2012.

Figure 3.11-4: Wetland and Upland Disturbance Types in the Mine Site Wetland Study Area



Source: 3PPI et al. 2012, 2014.

Figure 3.11-5: Mine Site Wetland Study Area Wetland Composition – Disturbed and All Wetlands

Preliminary results based on the HGM model developed by 3PPI (2014b) seem to indicate that approximately 91 percent of wetlands evaluated within the mine site wetland study area were high-functioning wetlands (FCI ≥ 0.66) for storm and floodwater storage, approximately 96 percent for modification of water quality, and approximately 96 percent for contribution to the abundance and diversity of wetland flora. Approximately 96 percent were modeled as moderate-functioning wetlands (FCI ≥ 0.33 and < 0.66) for modification of groundwater discharge, approximately 91 percent for modification of groundwater recharge, and approximately 61 percent for contribution to the abundance and diversity of wetland fauna. Approximately 92 percent were modeled as low-functioning wetlands (FCI < 0.33) for modification of stream flow, and approximately 80 percent for export of detritus. Function varied among HGM and wetland classes (Table 3.11-6, and Appendix K, Tables K-2 and K-3; 3PPI 2014b). Distribution of wetlands modeled as low moderate, and high-functioning for each of the eight wetland functions are shown in Figure 3.11-6A through Figure 3.11-6H. Disturbed and undisturbed wetlands within the mine site study area function essentially the same; with similar proportions of low (0.1 and 0.4 percent), moderate (94.3 and 93.3 percent), and high (5.7 and 6.2 percent) functioning wetlands, respectively, based on their average FCI scores. Regionally scarce wetlands in the mine site wetland study area include herbaceous wetlands and open water ponds (3PPI 2014b).

Table 3.11-6: Mine Site Wetland Study Area Preliminary Wetland Function Ratings by HGM Classes

Wetland Function Models	FCI Model Rating	HGM Class				Study Area (acres)	Area[1] (%)
		Depression	Flat	Slope	Riverine		
Hydrologic Functions							
Modification of Groundwater Discharge	Low	0	482.6	8.5	0	491.1	2%
	Mod	71.5	23,955.9	5,298.3	2,054.4	31,380.1	96%
	High	5.1	89.5	479.0	148.2	721.8	2%
Modification of Groundwater Recharge	Low	0	0	NA	0	0	0%
	Mod	71.7	24,135.9	NA	78.5	24,286.1	91%
	High	0	316.3	NA	2,062.0	2,378.3	9%
Storm and Floodwater Storage	Low	0	0	38.6	0.4	39.0	<1%
	Mod	9.5	52.3	799.3	1,957.1	2,818.3	9%
	High	67.1	24,784.1	4,959.1	245.1	30,055.4	91%
Modification of Stream Flow	Low	65.5	13,621.7	3,739.4	1,426.6	18,853.2	92%
	Mod	0.9	32.5	579.4	553.3	1,166.2	6%
	High	4.9	17.6	274.6	143.2	440.3	2%
Biogeochemical Functions							
Modification of Water Quality	Low	0	308.5	14.0	24.5	347.0	1%
	Mod	8.8	2.8	68.7	905.5	985.7	3%
	High	67.8	24,525.2	5,714.4	1,272.6	31,580.0	96%

Table 3.11-6: Mine Site Wetland Study Area Preliminary Wetland Function Ratings by HGM Classes

Wetland Function Models	FCI Model Rating	HGM Class				Study Area (acres)	Area[1] (%)
		Depression	Flat	Slope	Riverine		
Export of Detritus	Low	65.5	13,493.3	2,618.4	59.6	16,236.8	80%
	Mod	0.7	7.4	1,201.2	2.4	1,211.8	6%
	High	5.1	45.1	773.7	2,140.5	2,964.5	15%
Biological Functions							
Abundance and Diversity of Wetland Flora	Low	0	333.8	11.1	6.1	350.9	1%
	Mod	8.6	894.8	122.9	60.7	1,087.0	3%
	High	68.0	23,633.2	5,663.2	2,141.9	31,506.2	96%
Abundance and Diversity of Wetland Fauna	Low	0	333.8	11.3	6.1	351.1	1%
	Mod	76.0	16,683.8	1,243.8	1,989.0	19,992.6	61%
	High	0.7	7,844.1	4,542.0	213.6	12,600.4	38%

Notes:

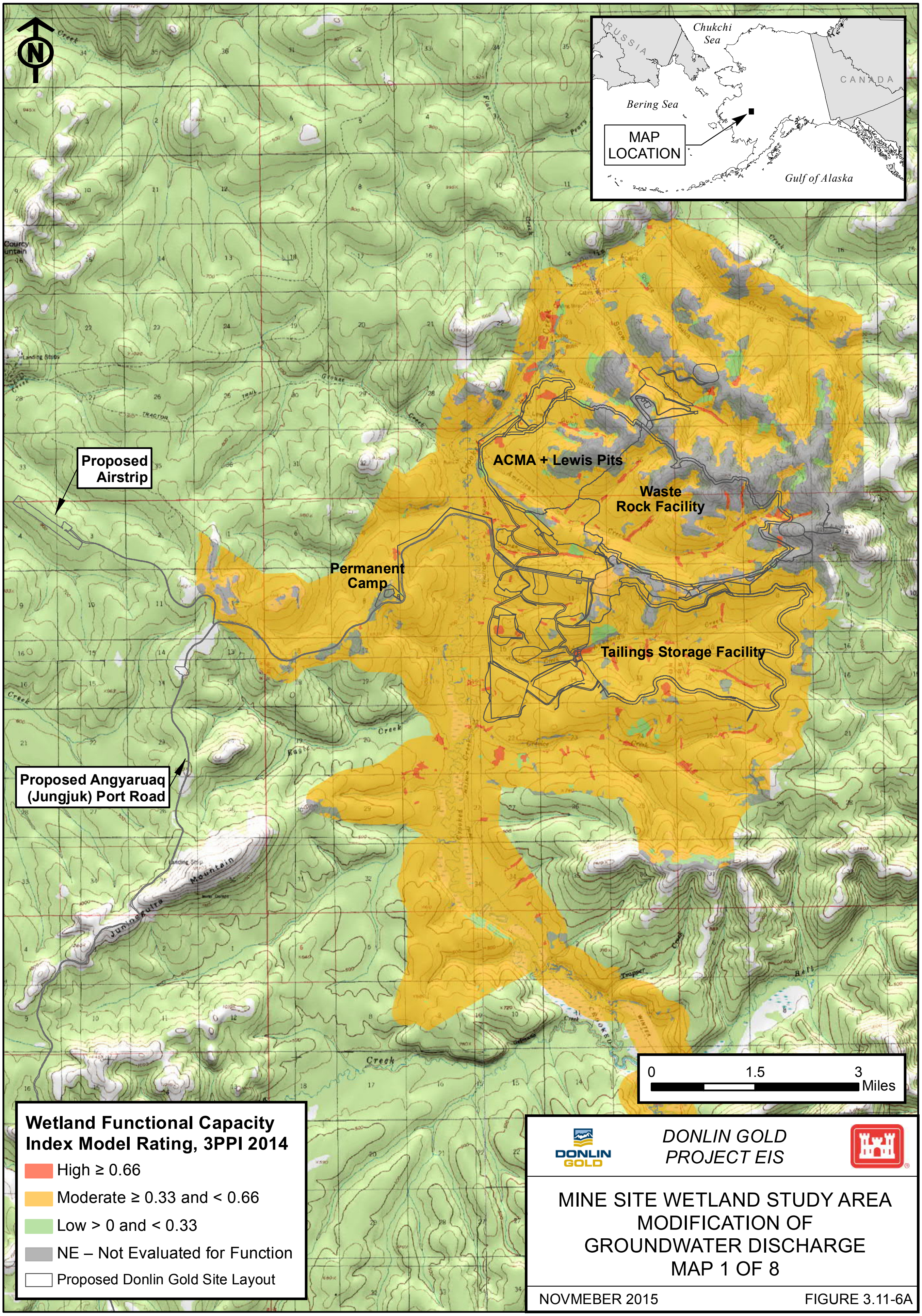
1 Proportion of total wetland area rated for the respective function within mine site wetland study area by Functional Capacity Index (FCI) rating (Low > 0 and < 0.33; Moderate (Mod) ≥ 0.33 and < 0.66; High ≥ 0.66). Note that mosaic classes calculated as 100% wetlands overestimate the wetland functional area proportion.

NA = Not Applicable

0 = None

0.0 = < 0.1

Source: 3PPI 2014b.

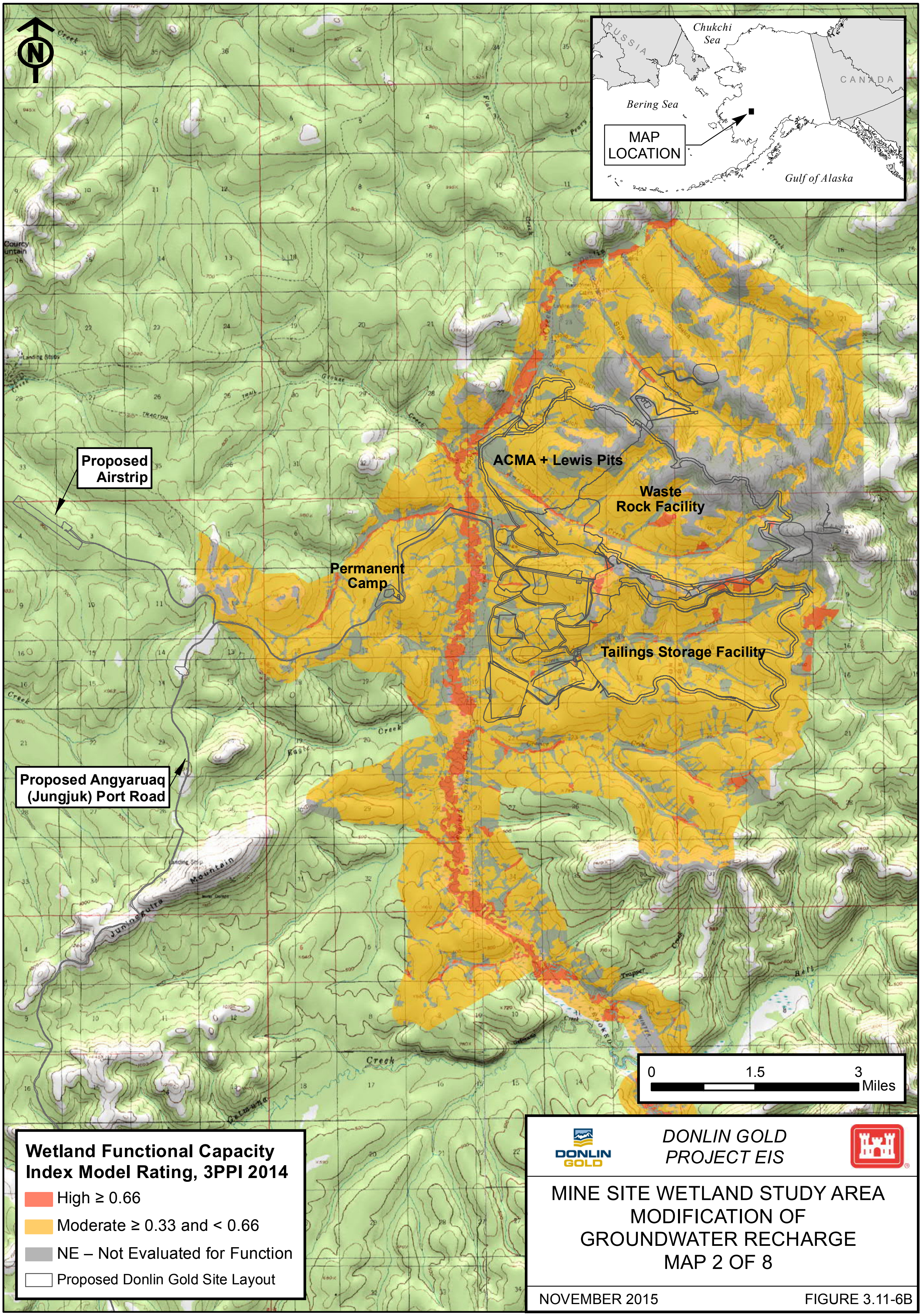


DONLIN GOLD
PROJECT EIS

MINE SITE WETLAND STUDY AREA
MODIFICATION OF
GROUNDWATER DISCHARGE
MAP 1 OF 8

NOVMEBER 2015

FIGURE 3.11-6A

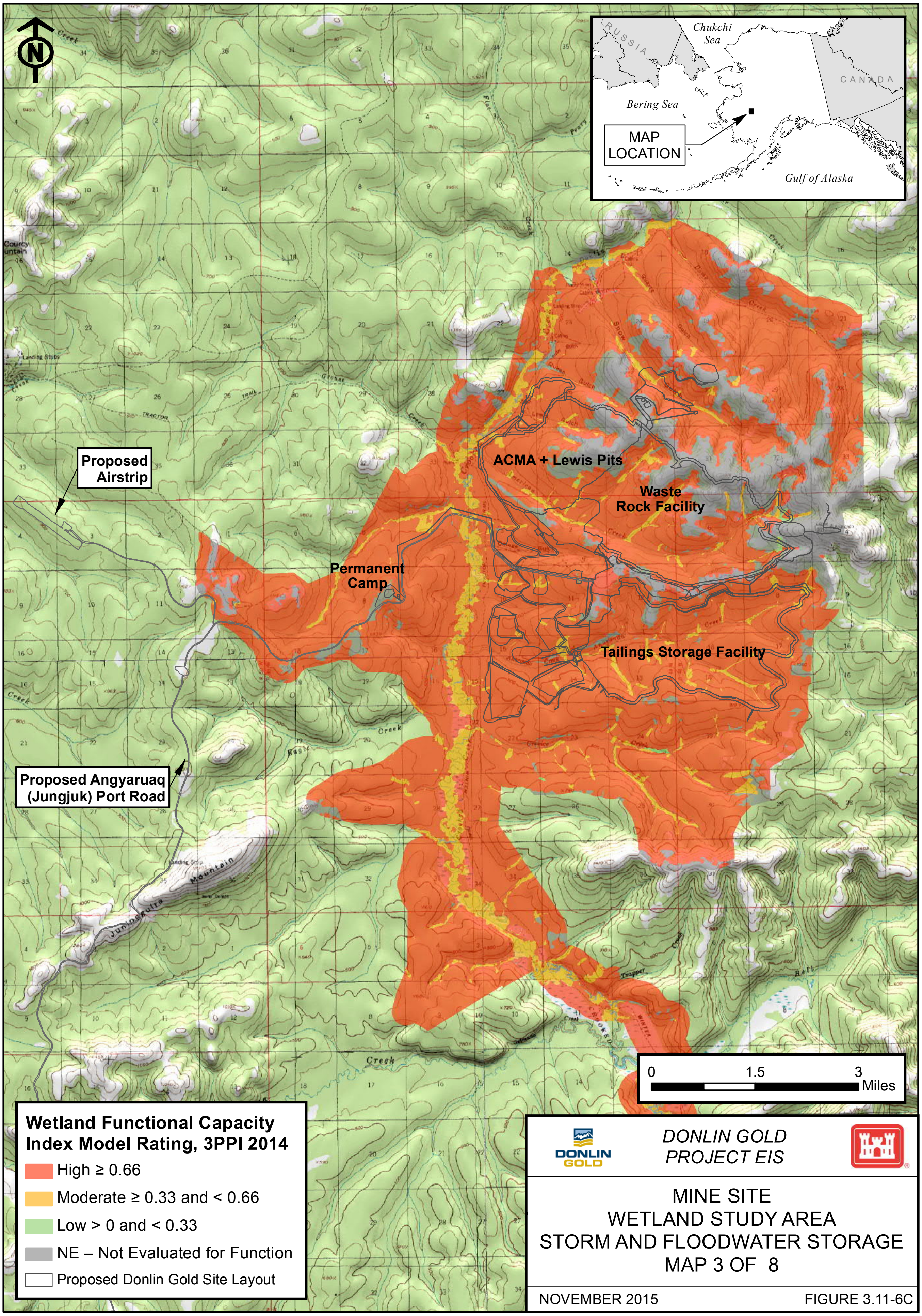


DONLIN GOLD PROJECT EIS

MINE SITE WETLAND STUDY AREA
MODIFICATION OF
GROUNDWATER RECHARGE
MAP 2 OF 8

NOVEMBER 2015

FIGURE 3.11-6B

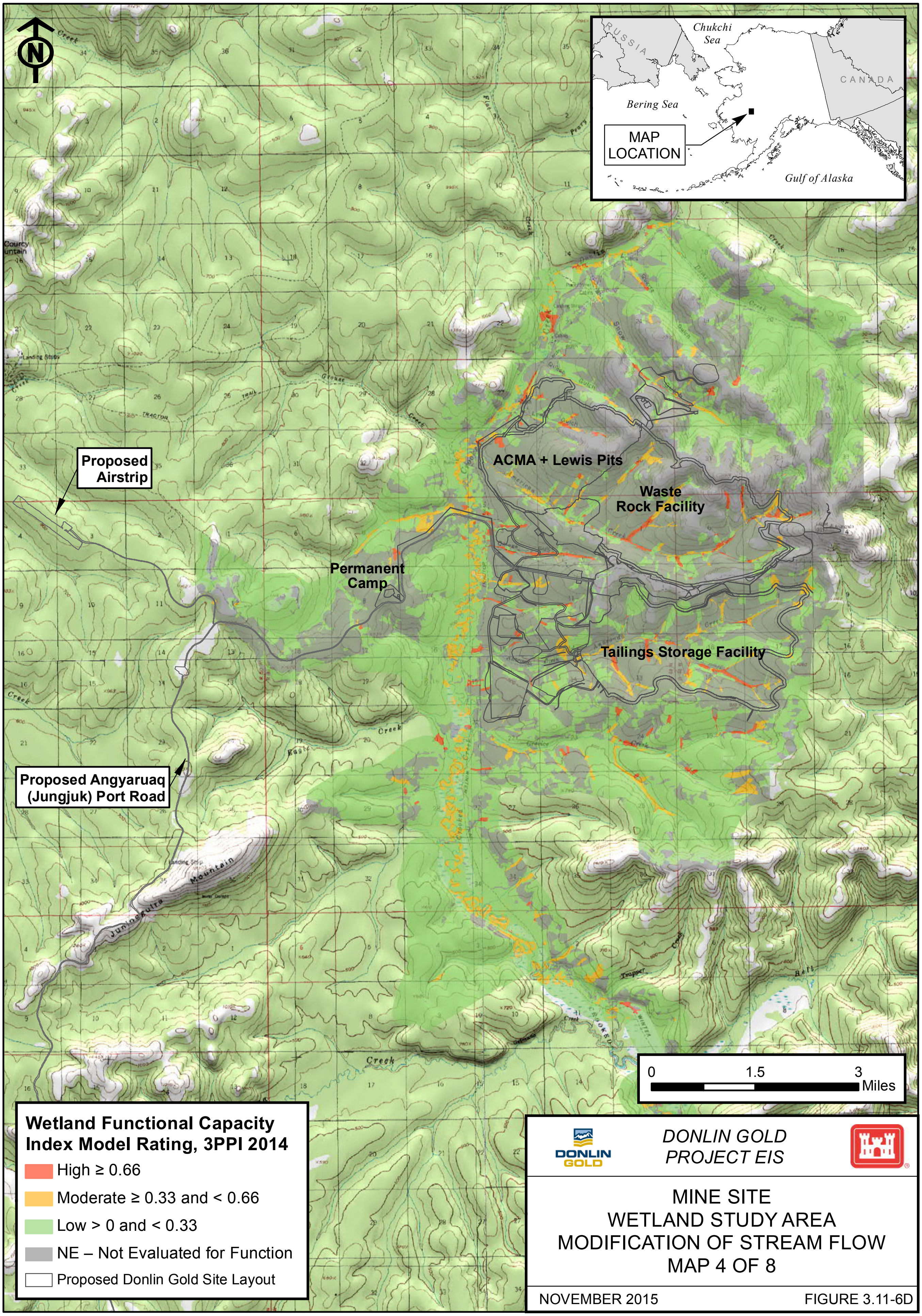


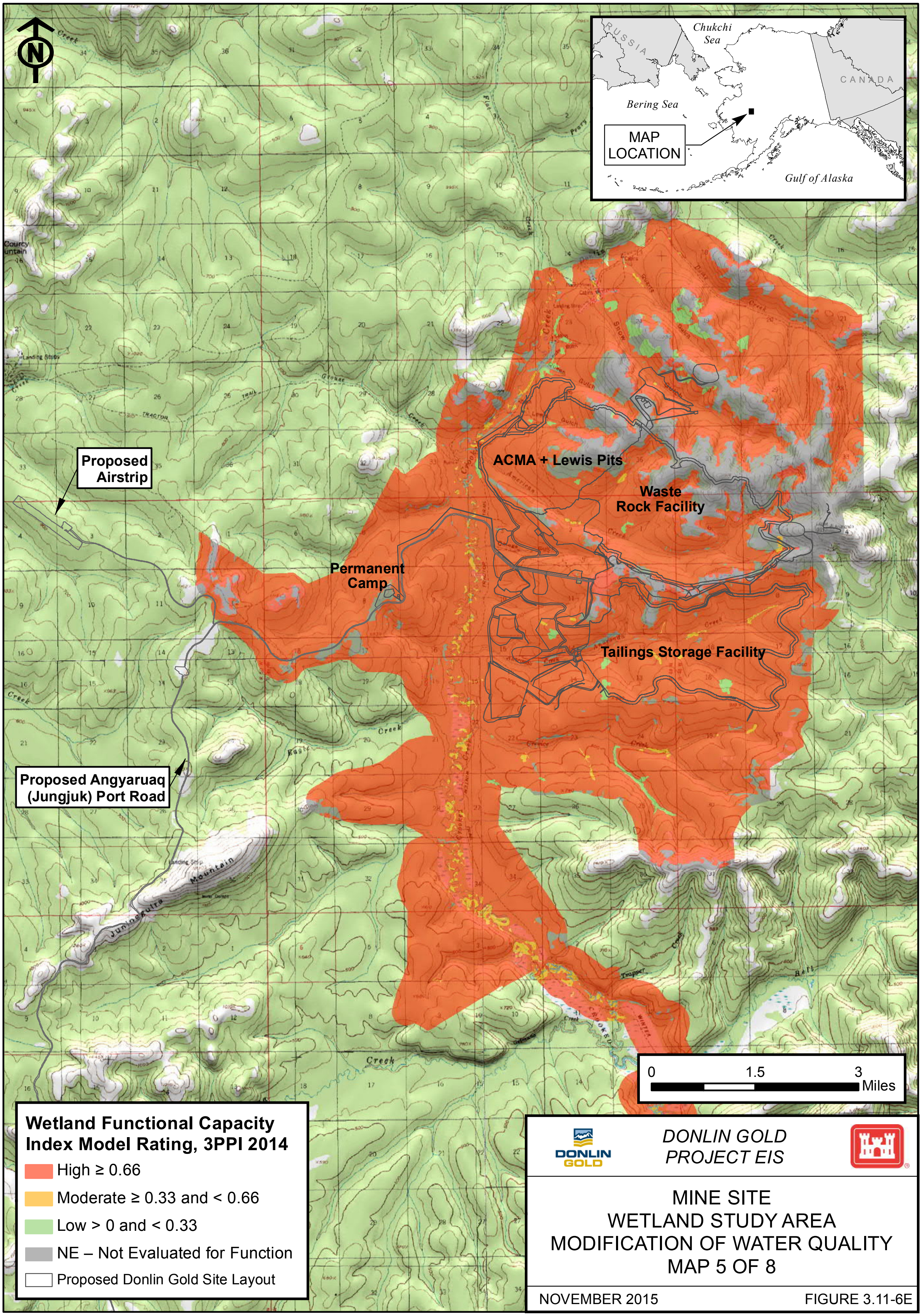
DONLIN GOLD PROJECT EIS

MINE SITE
WETLAND STUDY AREA
STORM AND FLOODWATER STORAGE
MAP 3 OF 8

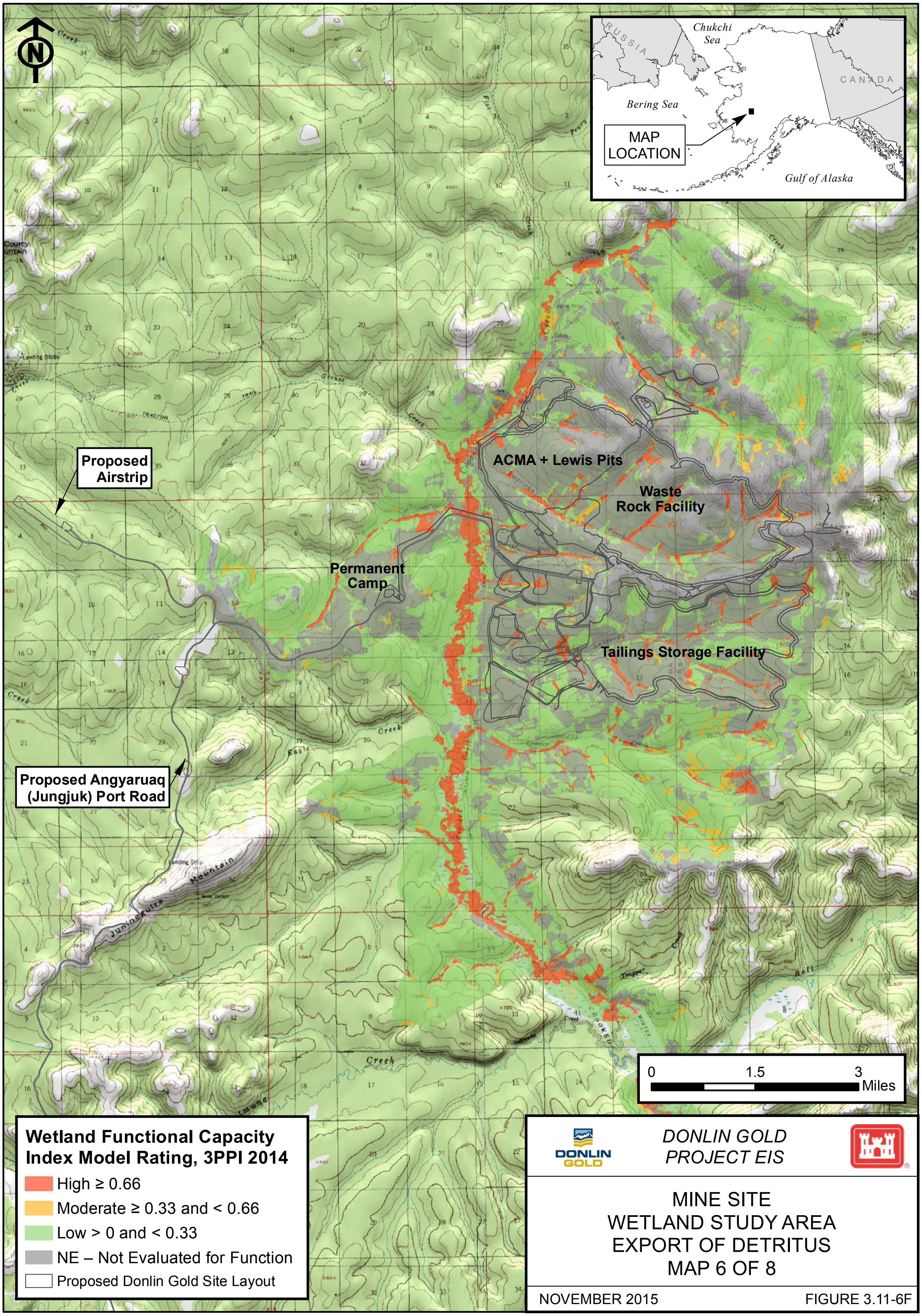
NOVEMBER 2015

FIGURE 3.11-6C


N
Chukchi Sea
RUSSIA
CANADA
Bering Sea
MAP LOCATION
Gulf of Alaska
ACMA + Lewis Pits
Waste Rock Facility
Permanent Camp
Tailings Storage Facility
Proposed Airstrip
Proposed Angyaruaq (Jungjuk) Port Road
0 1.5 3 Miles
Wetland Functional Capacity Index Model Rating, 3PPI 2014
High ≥ 0.66
Moderate ≥ 0.33 and < 0.66
Low > 0 and < 0.33
NE – Not Evaluated for Function
Proposed Donlin Gold Site Layout
DONLIN GOLD
DONLIN GOLD PROJECT EIS
MINE SITE
WETLAND STUDY AREA
MODIFICATION OF STREAM FLOW
MAP 4 OF 8
NOVEMBER 2015
FIGURE 3.11-6D



Chukchi Sea
RUSSIA
CANADA
Bering Sea
MAP LOCATION
Gulf of Alaska
Proposed Airstrip
ACMA + Lewis Pits
Waste Rock Facility
Permanent Camp
Tailings Storage Facility
Proposed Angyaruaq (Jungjuk) Port Road
0
1.5
3
Miles
Wetland Functional Capacity Index Model Rating, 3PPI 2014
High ≥ 0.66
Moderate ≥ 0.33 and < 0.66
Low > 0 and < 0.33
NE – Not Evaluated for Function
Proposed Donlin Gold Site Layout
DONLIN GOLD
DONLIN GOLD PROJECT EIS
MINE SITE
WETLAND STUDY AREA
MODIFICATION OF WATER QUALITY
MAP 5 OF 8
NOVEMBER 2015
FIGURE 3.11-6E

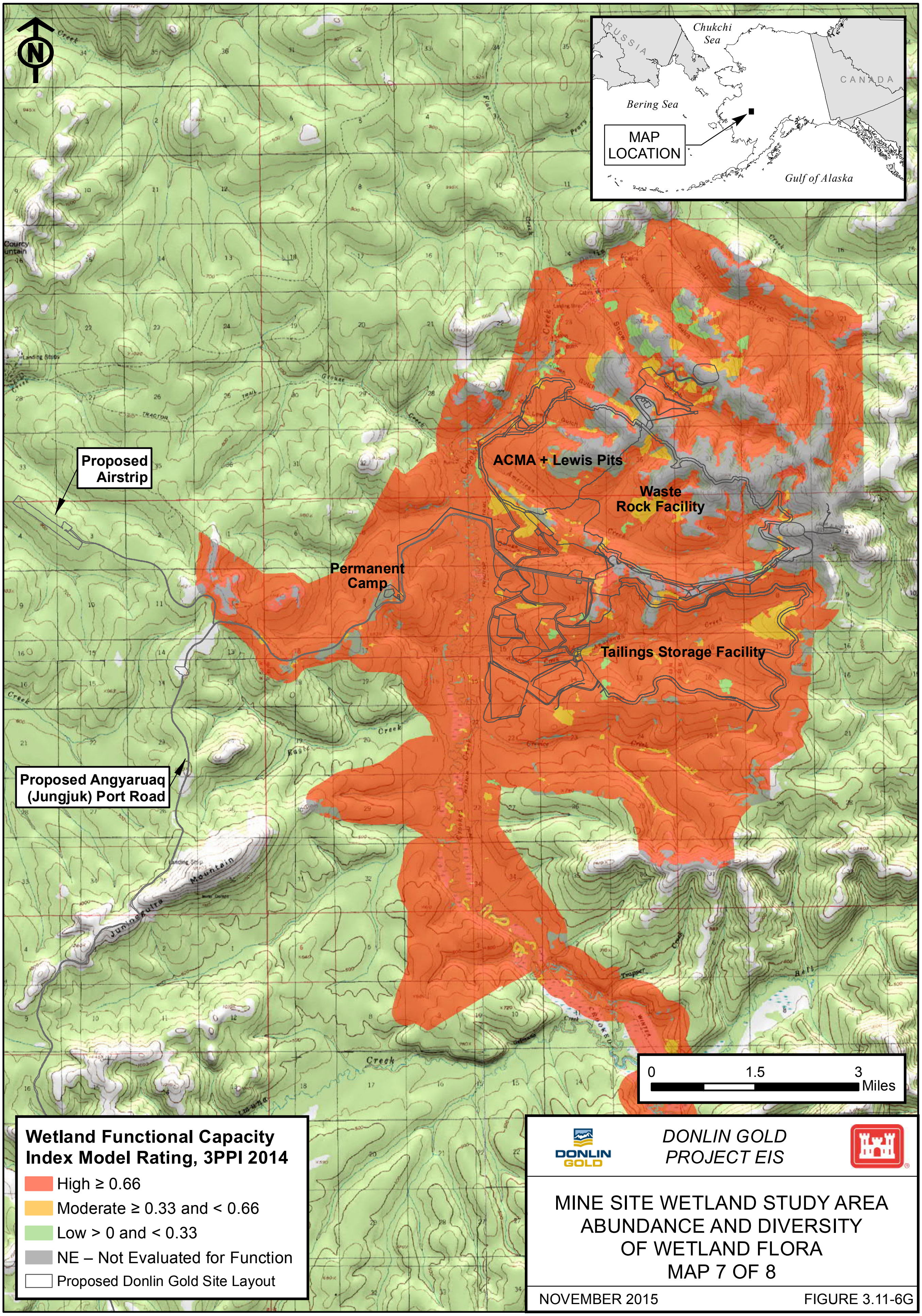


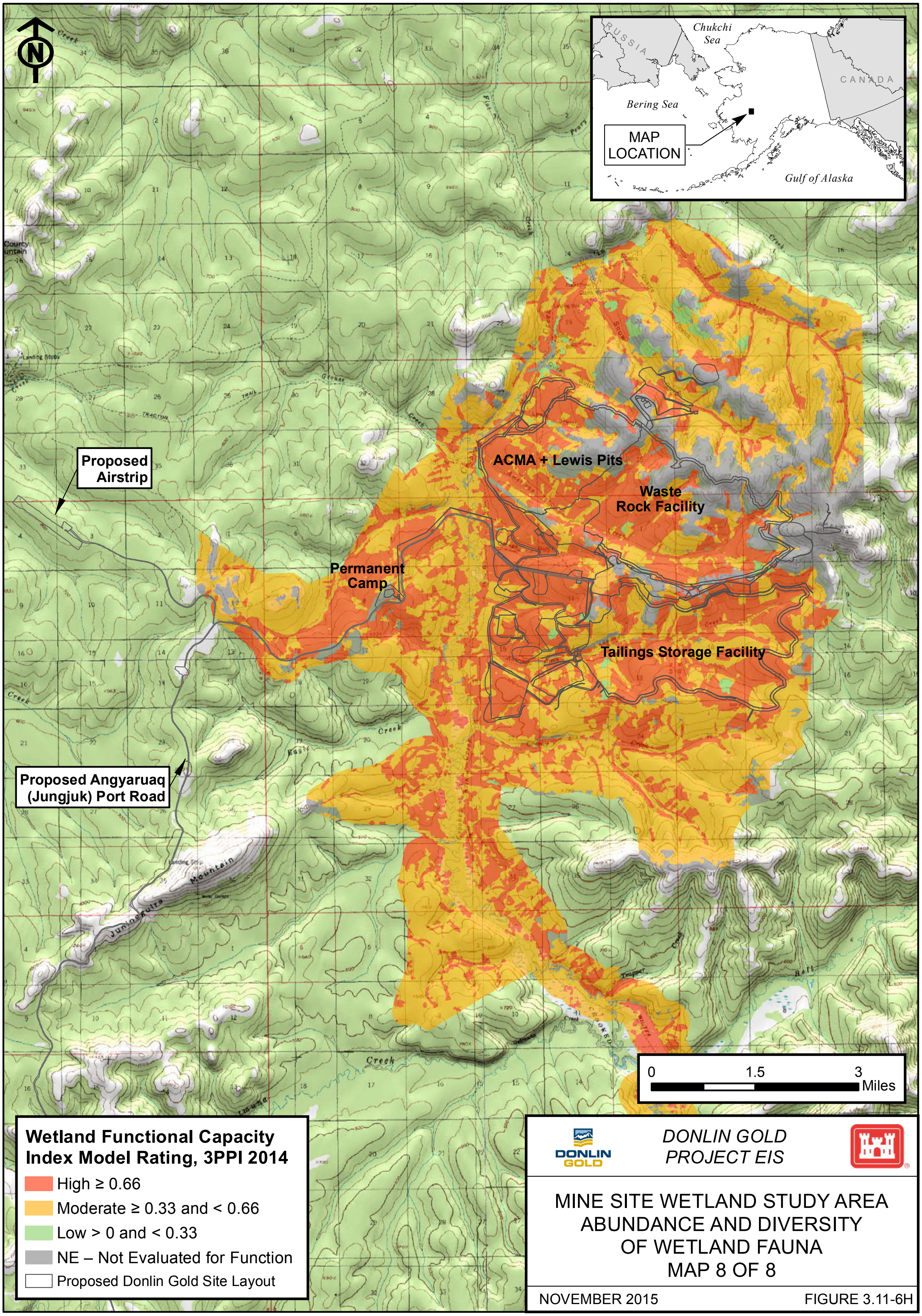
DONLIN GOLD PROJECT EIS

MINE SITE
WETLAND STUDY AREA
EXPORT OF DETRITUS
MAP 6 OF 8

NOVEMBER 2015

FIGURE 3.11-6F


N
Chukchi Sea
RUSSIA
Bering Sea
CANADA
MAP LOCATION
Gulf of Alaska
Proposed Airstrip
ACMA + Lewis Pits
Waste Rock Facility
Permanent Camp
Tailings Storage Facility
Proposed Angyaruaq (Jungjuk) Port Road
0
1.5
3
Miles
Wetland Functional Capacity Index Model Rating, 3PPI 2014
High ≥ 0.66
Moderate ≥ 0.33 and < 0.66
Low > 0 and < 0.33
NE – Not Evaluated for Function
Proposed Donlin Gold Site Layout
DONLIN GOLD
DONLIN GOLD PROJECT EIS
MINE SITE WETLAND STUDY AREA ABUNDANCE AND DIVERSITY OF WETLAND FLORA MAP 7 OF 8
NOVEMBER 2015
FIGURE 3.11-6G



DONLIN GOLD PROJECT EIS

MINE SITE WETLAND STUDY AREA
ABUNDANCE AND DIVERSITY
OF WETLAND FAUNA
MAP 8 OF 8

NOVEMBER 2015

FIGURE 3.11-6H

3.11.3.2 TRANSPORTATION FACILITIES

3.11.3.2.1 MINE TRANSPORTATION WETLAND STUDY AREA

Eighty-two percent of the mine transportation wetland study area is wetland (including mosaics); wetlands are predominately evergreen forested and evergreen and deciduous scrub shrub wetlands in flat or slope geomorphic settings (Table 3.11-7, Figure 3.11-7). The mine transportation study area is a mosaic of upland, wetland, and transitional areas (3PPI et al. 2014). Wetland distribution and extent are influenced by discontinuous permafrost. Common wetland communities along the access road and airstrip include: black spruce forested wetlands on north-facing hillsides and toe slopes; willow-dominated shrub wetlands in creek drainages; moist tundra dominated tussock cotton grass on hillsides, slopes, or valley bottoms; and shrub bogs and sedge marshes in valley bottoms (Figure 3.11-7; ARCADIS 2013a). Wetlands near the Angyaruaq (Jungjuk) and BTC port sites and along the Kuskokwim River include wetlands influenced by the river including floodplain forests, shrub and emergent wetlands. Figure 3.11-8 shows wetlands in the mine transportation wetland study area.

Rivers and streams within the mine transportation study area total 294 miles with 90 percent perennial streams and rivers (263 miles), and 10 percent intermittent streams (31 miles) (Table 3.11-7; 3PPI et al. 2014).

Previous disturbances were to 48 percent wetlands and 52 percent uplands within the mine transportation study area and have been caused by recent wildland fires (62 percent) and a variety of ongoing human activities including: Donlin Gold's exploration drill roads and pads (12 percent); as well as historic human activities such as use of winter trails and the Crooked Creek village site (25 percent; 3PPI et al. 2014). As in the mine site study area, disturbed areas represent a disproportionate amount (96 percent) of deciduous scrub shrub wetlands, possibly reflecting succession or revegetation within disturbed areas. Note that due to overlap of the mine site and mine transportation study areas 36 percent of the disturbed wetland areas noted in the mine transportation study area also occur in the mine site study area.

Table 3.11-7: Mine Transportation Wetland Study Area Preliminary Calculation of Wetland Categories by HGM Classes

Wetland Category	HGM Class (acres)					Area (acres)	Area[1] (%)
	Depression	Flat	Slope	Riverine	River Channel		
Evergreen Forested Wetlands	0.3	17,020.3	2,144.8	497.9	0	19,663.3	36%
Deciduous Forested Wetlands	0	74.1	78.6	146.6	0	299.3	1%
Mixed Forested Wetlands	0.9	219.4	1,979.4	1,216.7	0	3,416.4	6%
Evergreen Scrub Shrub Wetlands	2.4	6,258.9	2,245.6	47.1	0	8,554.1	16%
Deciduous Scrub Shrub Wetlands	16.9	5,846.2	2,345.2	859.9	0	9,068.2	17%

Table 3.11-7: Mine Transportation Wetland Study Area Preliminary Calculation of Wetland Categories by HGM Classes

Wetland Category	HGM Class (acres)					Area (acres)	Area[1] (%)
	Depression	Flat	Slope	Riverine	River Channel		
Herbaceous Wetlands	111.0	2,491.7	1,059.2	193.9	0	3,855.8	7%
Ponds	13.1	0	0	38.0	0.9	52.0	<1%
Lakes	0	0	0	0	0	0	NA
Rivers	0	0	0	0	644.4	644.4	1%
Intermittent Streams (mile)	NA	NA	NA	NA	NA	30.7	10%
Perennial Streams (miles)	NA	NA	NA	NA	NA	263.5	90%
Uplands	NA	NA	NA	NA	NA	8,992.9	16%
Area (acre)	144.7	31,910.5	9,852.8	3,000.2	645.3	54,546.4	NA
Wetland Area (%, acre)	<1%	70%	22%	7%	1%	44,857.1	84%

Notes:

1 Proportion of total study area by wetland category. Note that mosaic classes calculated as 100% wetlands overestimate the wetland area proportion.

NA = Not Applicable
0 = None
0.0 = < 0.1

Source: 3PPI et al. 2014.

Evergreen Forested Wetland, PF04B, Open Spruce Forest-Moss Lichen Understory, Return Creek Watershed

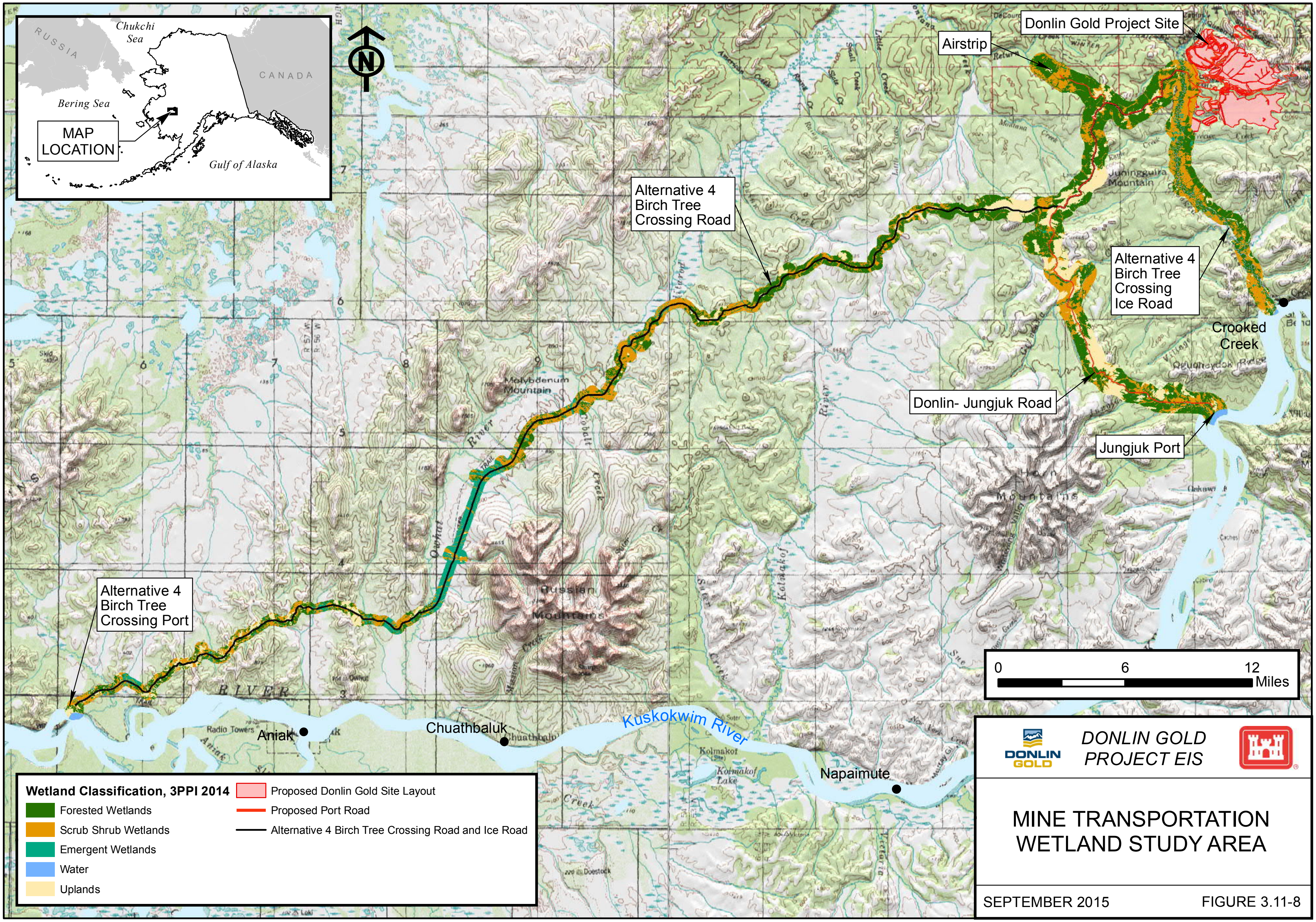
Evergreen Forested Wetland, PF04B, Open Black Spruce Forest-Shrub, Getmuna Creek Watershed

Deciduous Scrub Shrub Wetland, PSS1C, Closed Alder Willow Shrub, Getmuna Creek Watershed

Herbaceous Wetland, PEM1B, Bluejoint Tall Grass, Getmuna Creek Watershed

Source: 3PPI et al. 2012; 3PPI 2014a

Figure 3.11-7: Common Wetland Types in the Mine Transportation Wetland Study Area



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MINE TRANSPORTATION WETLAND STUDY AREA

SEPTEMBER 2015

FIGURE 3.11-8

Functional assessment data were available only for the portion of the mine transportation wetland study area covering the Angyaruaq (Jungjuk) road and port. Preliminary results based on the HGM model developed by 3PPI (2014b) seem to indicate that approximately 90 percent of wetlands evaluated within the mine transportation wetland study area were high-functioning wetlands (FCI ≥0.66) for storm and floodwater storage, approximately 96 percent for modification of water quality, and approximately 98 percent for contribution to the abundance and diversity of wetland flora. Approximately 96 percent were modeled as moderate-functioning wetlands (FCI ≥0.33 and <0.66) for modification of groundwater discharge, approximately 88 percent for modification of groundwater recharge, and approximately 63 percent for contribution to the abundance and diversity of wetland fauna. Approximately 93 percent were modeled as low-functioning wetlands (FCI <0.33) for modification of stream flow, and approximately 73 percent for export of detritus. Function varied among HGM and wetland classes (Table 3.11-8, and Appendix K, Tables K-4 and K-5; 3PPI 2014b). Regionally scarce wetlands in the mine transportation wetland study area include herbaceous wetlands and open water ponds (3PPI 2014b).

Table 3.11-8: Mine Transportation Wetland Study Area Preliminary Wetland Function Ratings by HGM Classes

Wetland Function Models	FCI Model Rating	HGM Class				Study Area[1] (acres)	Area[2] (%)
		Depression	Flat	Slope	Riverine		
Hydrologic Functions							
Modification of Groundwater Discharge	Low	0.0	413.6	4.5	0.4	418.5	2%
	Mod	64.6	16,852.5	5,247.1	2,262.4	24,426.5	96%
	High	5.1	48.6	437.5	75.6	566.8	2%
Modification of Groundwater Recharge	Low	0	0	NA	0	0	0%
	Mod	64.8	17,080.0	NA	44.5	17,189.2	88%
	High	0.0	192.2	NA	2,260.3	2,452.5	12%
Storm and Floodwater Storage	Low	0	0	6.1	3.0	9.1	<1%
	Mod	9.2	16.5	493.7	2,139.5	2,658.9	10%
	High	60.5	17,308.5	5,190.0	195.8	22,754.8	90%
Modification of Stream Flow	Low	62.5	10,373.9	4,420.8	1,596.9	16,454.1	93%
	Mod	0.9	3.2	216.3	526.1	746.6	4%
	High	4.9	13.3	305.0	125.5	448.7	3%
Biogeochemical Functions							
Modification of Water Quality	Low	0	10.3	0.7	2.8	13.8	<1%
	Mod	8.5	0	68.6	1,024.8	1,101.9	4%
	High	61.3	17,314.7	5,620.5	1,310.7	24,307.1	96%
Export of Detritus	Low	62.5	10,351.2	2,492.9	31.7	12,938.3	73%
	Mod	0.7	7.4	2,004.4	2.4	2,014.9	11%
	High	5.2	9.0	444.9	2,304.1	2,763.3	16%

Table 3.11-8: Mine Transportation Wetland Study Area Preliminary Wetland Function Ratings by HGM Classes

Wetland Function Models	FCI Model Rating	HGM Class				Study Area[1] (acres)	Area[2] (%)
		Depression	Flat	Slope	Riverine		
Biological Functions							
Abundance and Diversity of Wetland Flora	Low	0	15.5	1.5	1.1	18.2	<1%
	Mod	8.4	321.7	76.5	34.4	441.0	2%
	High	61.3	16,993.0	5,611.7	2,303.9	24,970.0	98%
Abundance and Diversity of Wetland Fauna	Low	0	15.5	0	1.1	16.6	<1%
	Mod	69.4	12,066.2	1,780.4	2,169.0	16,085.0	63%
	High	0.3	5,248.6	3,909.4	169.3	9,327.6	37%

Notes:

1 The functional assessment did not include the Birch Tree Crossing access route; total functional assessment area was 32,692 acres with a preliminary estimated16,980 acres of wetlands.

2 Proportion of total wetland area rated for the respective function within mine transportation wetland study area by Functional Capacity Index (FCI) rating (Low > 0 and < 0.33; Moderate (Mod) ≥ 0.33 and < 0.66; High ≥ 0.66). Note that mosaic classes calculated as 100% wetlands overestimate the wetland functional area proportion.

NA = Not Applicable 0 = None 0.0 = < 0.1

Source: 3PPI 2014b.

3.11.3.2.2 KUSKOKWIM RIVER WETLAND STUDY AREA

Twenty-eight percent of the Kuskokwim River wetland study area is wetland and 60 percent is upland. Wetlands include woody wetlands with either forest or shrubland vegetation and soils that are periodically saturated or covered with water or are emergent herbaceous wetlands with perennial herbaceous vegetation (Table 3.11-9, Figure 3.11-9; Homer et al. 2004). Riparian wetland habitats and vegetation are reshaped by flooding, and by flooding with melting followed by subsequent collapse of permafrost-supported shorelines (thermoerosional niching; BGC 2007c). Permafrost is generally absent within the river channel, although permafrost may develop within floodplains in mixed stands of 200-year old white and black spruce because of accumulated thick insulating layers of moss and organics (Post 1996).

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KUSKOKWIM RIVER WETLAND STUDY AREA

NOVEMBER 2015

FIGURE 3.11-9

Table 3.11-9: Kuskokwim River Study Area Wetland Categories

Wetland Category	Area (acres)	Area (%)
Woody Wetlands	138,976	13%
Emergent Herbaceous Wetlands	164,479	15%
Water	125,634	12%
Uplands	634,801	60%
Area (acre)	1,063,890	NA

Notes:

NA = Not Applicable

Source: Homer et al. 2004.

Overlay of available digital NWI data covering 195 miles of the Kuskokwim River mapped from circa 1980s imagery (FWS 2014a) with deposition and erosion areas identified by shoreline changes between 1988 and 2006 (ARCADIS 2007a; Figure 3.11-10A and Figure 3.11-10B) indicates:

- Deposition rates (acres/mile) were less than 25 percent of erosion rates (the river is actively moving and eroding banks),
- Wetland erosion rates decreased substantially from downstream to upstream,
- Upland erosion occurred in river segments upstream from Tuluksak, and

Overall erosion rates decreased 10-fold within segments from downstream of Bethel to upstream of Aniak (Table 3.11-10 and Figure 3.11-11).

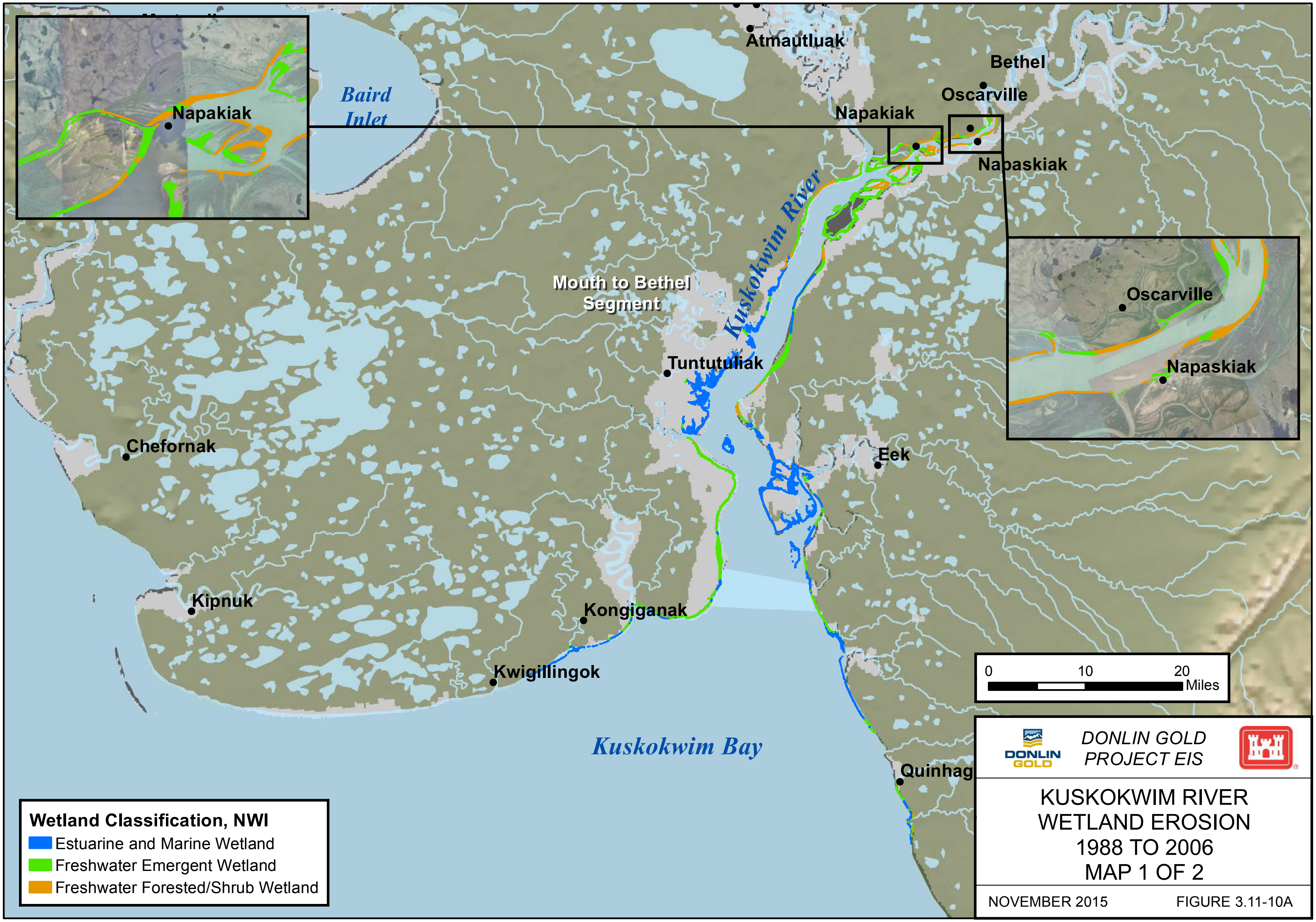
Table 3.11-10: Kuskokwim River Segment Wetland Deposition and Erosion Rates (acres/mile) between 1988 and 2006

Wetland Type		Kuskokwim River Segments[1]				
		Mouth to Bethel	Tuluksak	Kalskag	Aniak to Napaimute	Combined Segments
Estuarine and Marine Wetland	Deposition	11.88	0.00	0.00	0.00	5.17
	Erosion	88.64	0.00	0.00	0.00	38.57
Freshwater Emergent Wetland	Deposition	1.23	0.00	0.00	0.00	0.54
	Erosion	65.44	0.47	1.56	0.04	29.00
Freshwater Forested/ Shrub Wetland	Deposition	0.17	1.47	0.62	0.73	0.50
	Erosion	9.18	31.75	6.62	3.06	8.56
Wetlands	Deposition	13.28	1.47	0.63	0.73	6.20
	Erosion	163.26	32.22	8.18	3.09	76.13
Uplands	Deposition	0.00	0.00	0.99	2.15	0.72
	Erosion	0.00	0.00	36.63	13.46	13.98
Total	Deposition	13.28	1.47	1.62	2.88	6.93
	Erosion	163.26	32.22	44.80	16.56	90.12
Deposition to Erosion (%)		8%	5%	8%	23%	8%

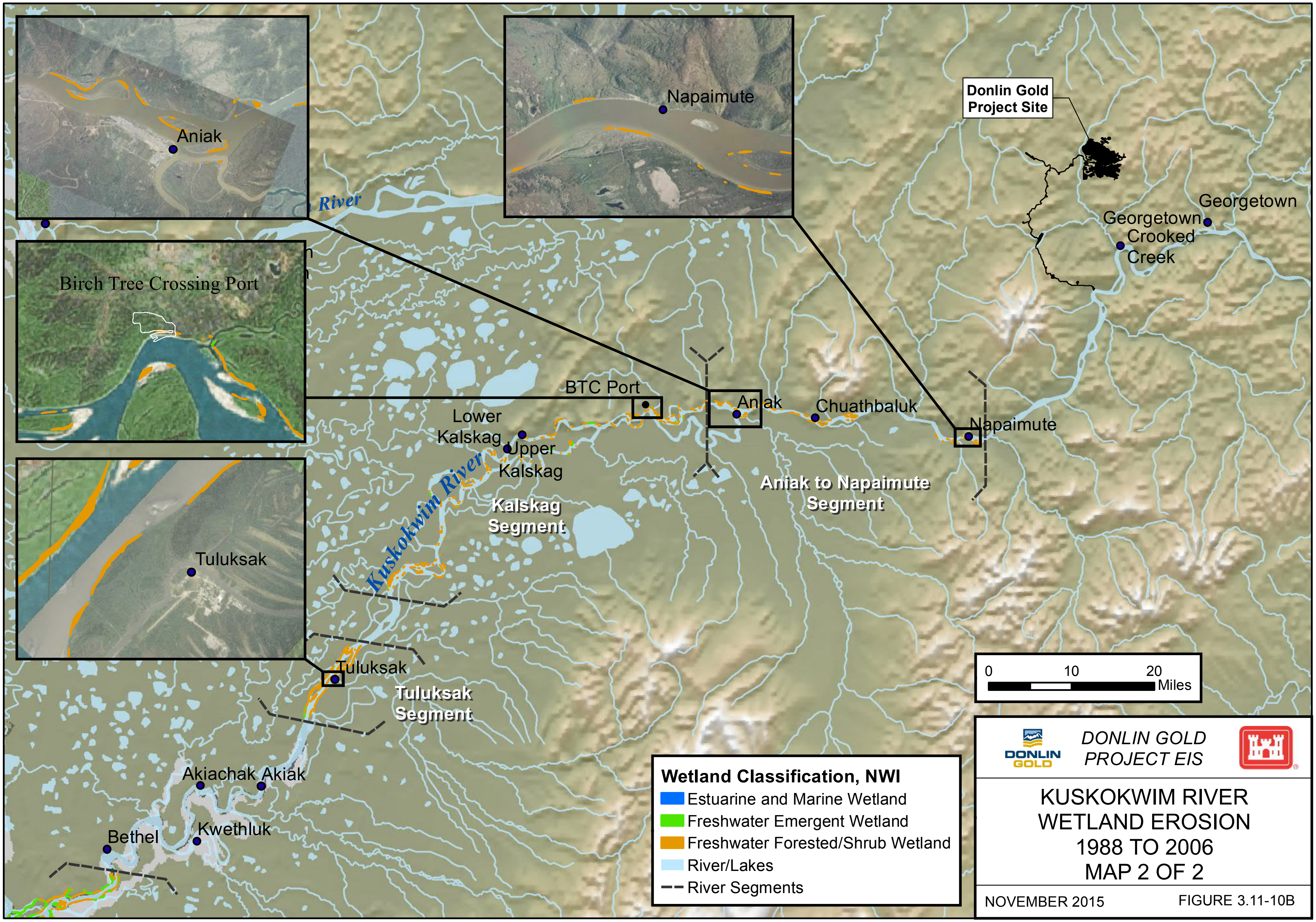
Notes:

1 River Segment Lengths: Mouth to Bethel – 84.9 miles; Tuluksak – 11.8 miles; Kalskag – 60.6 miles; Aniak to Napaimute – 37.8 miles; Combined Segments – 195.1.

Source: Analysis based on ARCADIS 2007a; FWS 2014a.



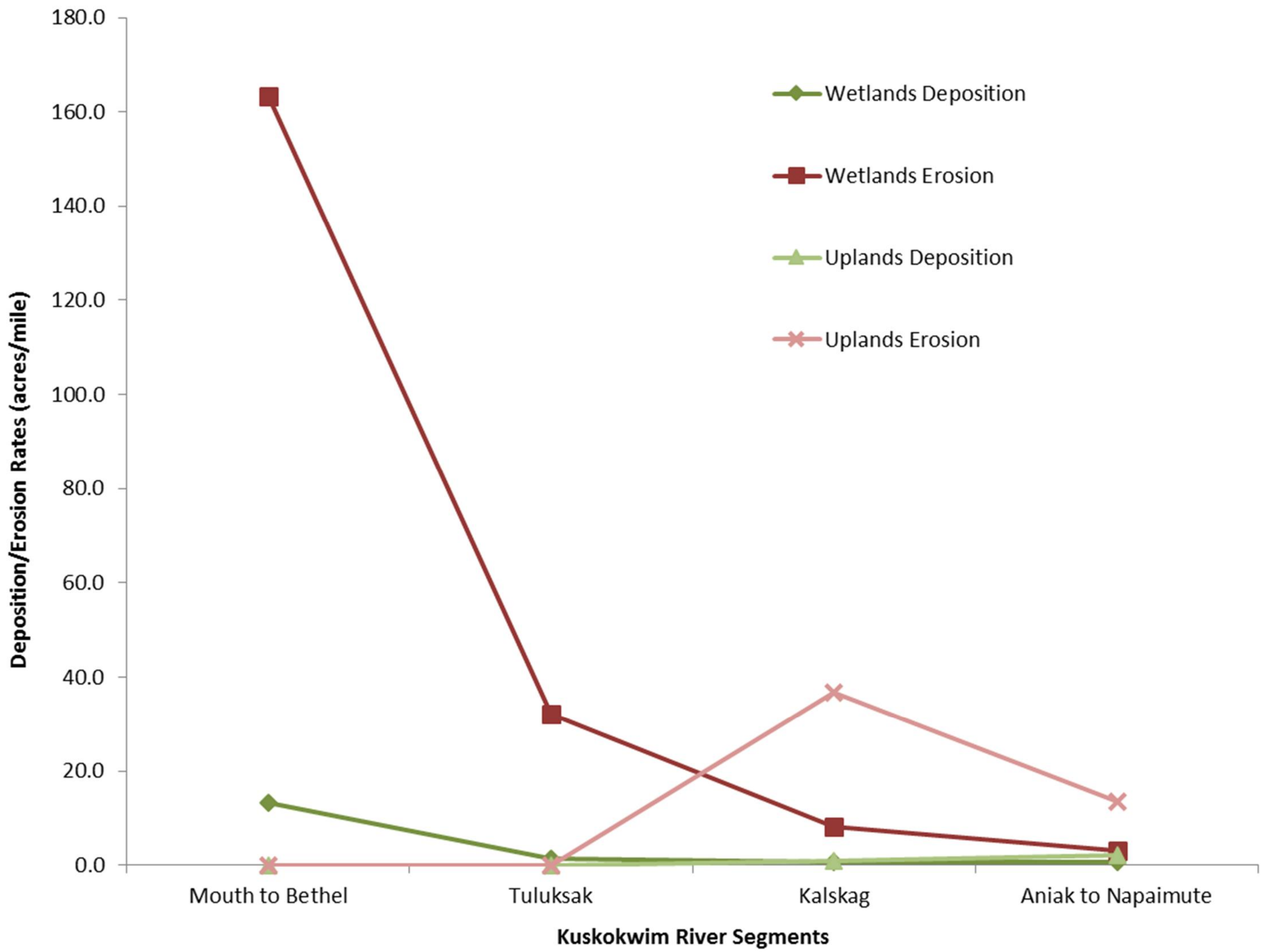
Napakiak
Baird Inlet
Atmautluak
Bethel
Oscarville
Napakiak
Napaskiak
Kuskokwim River
Mouth to Bethel Segment
Tuntutuliak
Oscarville
Napaskiak
Chefornak
Eek
Kipnuk
Kongiganak
Kwigillingok
0
10
20
Miles
Kuskokwim Bay
Quinhagak
Wetland Classification, NWI
Estuarine and Marine Wetland
Freshwater Emergent Wetland
Freshwater Forested/Shrub Wetland
DONLIN GOLD
DONLIN GOLD PROJECT EIS
KUSKOKWIM RIVER WETLAND EROSION 1988 TO 2006 MAP 1 OF 2
NOVEMBER 2015
FIGURE 3.11-10A



KUSKOKWIM RIVER WETLAND EROSION 1988 TO 2006 MAP 2 OF 2

NOVEMBER 2015

FIGURE 3.11-10B



Source: ARCADIS 2007a; FWS 2014a.

Figure 3.11-11: Kuskokwim River Wetland Deposition and Erosion Rates by River Segment 1988 to 2006

3.11.3.2.3 BETHEL WETLAND STUDY AREA

Wetlands along the Kuskokwim River in the vicinity of the proposed 16-acre cargo terminal may include wet graminoid, dwarf shrub-*Sphagnum* peatlands, and tall alder-willow shrub habitats and shoreline and riverine habitats (Boggs et al. 2012). The fuel terminal and tank farm would be constructed within existing facilities by Delta Western, likely in upland habitats.

3.11.3.3 PIPELINE WETLAND STUDY AREA

Forty-five percent of the pipeline wetland study area is wetland (including mosaics). Wetlands throughout the pipeline route are predominately deciduous scrub shrub wetlands and evergreen forested and scrub shrub wetlands in flat or slope geomorphic settings (Table 3.11-11, Figure 3.11-12, and Figure 3.11-13A through Figure 3.11-13H). The pipeline ROW crosses four ecoregions, each with differing wetland abundance and type (Figure 3.11-14 and Table 3.11-11). Wetlands across the Kuskokwim Mountains region, from MP 221 to MP 315 of the pipeline, include alpine wetlands scattered along the route that are dominated by dwarf and low shrubs, and are sometimes underlain by permafrost or seasonally persistent frost (ARCADIS 2013a). Wetlands across the Tanana-Kuskokwim Lowlands ecoregion from MP 156 to MP 221 are dominated by scrub black spruce forested wetland in the western portion, much of which is underlain by permafrost, and drainages are dominated by willows. In the eastern portion, the wetlands are dominated by tussock grass tundra (ARCADIS 2013a). Wetlands across the Alaska Range region from MP 82 to MP 156 include: black spruce-dominated forested wetlands; scattered bogs and fens; riparian willow-dominated wetlands that have been modified by beavers; and shrub-dominated moist tundra (ARCADIS 2013a). Wetlands across the Cook Inlet Basin region from MP 0 to MP 82 include: patterned bogs; black spruce forested wetlands; and willow-dominated wetlands on river and stream floodplains (ARCADIS 2013a). Most wetlands fall within flat and slope HGM classes, although the area of each varies within ecoregions (Figure 3.11-15).

Rivers and streams within the pipeline wetland study area total 510 miles with 60 percent of these perennial streams and rivers (307 miles), and 40 percent intermittent streams (203 miles) (Table 3.11-11; 3PPI et al. 2014). Within the pipeline wetland study area, the Cook Inlet Basin Ecoregion has the greatest length of streams with 150 miles, followed by the Alaska Range with 137 miles, then the Kuskokwim Mountains with 114 miles, and finally the Tanana-Kuskokwim Lowlands with 109 miles (Table 3.11-11; 3PPI et al. 2014).

Disturbances in the pipeline wetland study area have been primarily to uplands, affecting 88 percent uplands and 12 percent wetlands (3PPI et al. 2014). Most disturbed wetland habitats (98 percent) were within the Alaska Range (54 percent) and Cook Inlet Basin (44 percent) ecoregions. When they were identified, wetland disturbances included roads (56 percent), vegetation clearing (28 percent), burned areas (14 percent), and trails (3 percent) (3PPI et al. 2014). Previously disturbed wetland areas occurred within deciduous (52 percent) and evergreen (20 percent) scrub shrub wetlands and herbaceous wetlands (24 percent) (3PPI et al. 2014).

Table 3.11-11: Pipeline Wetland Study Area Preliminary Calculation of Wetland Categories by Ecoregion

Wetland Category	Ecoregion (acres)				Area (acres)	Area[2] (%)
	Kuskokwim Mountains	Tanana-Kuskokwim Lowlands	Alaska Range	Cook Inlet Basin[1]		
Evergreen Forested Wetlands	3,798.0	3,773.9	3,099.4	1,875.0	12,546.3	11%
Deciduous Forested Wetlands	106.5	145.6	41.5	711.0	1,004.5	1%
Mixed Forested Wetlands	997.0	371.9	299.0	2,269.4	3,937.2	4%
Evergreen Scrub Shrub Wetlands	1,968.2	2,727.2	987.5	1,271.0	6,953.9	6%
Deciduous Scrub Shrub Wetlands	3,058.3	7,094.8	6,664.5	6,316.3	23,134.0	21%
Fens (ESB-SB)	19.6	5.8	12.7	1,759.4	1,797.5	2%
Bogs (LSB)	593.5	3,255.0	764.3	1,860.6	6,473.5	6%
Herbaceous Wetlands	92.8	551.6	489.8	734.4	1,868.6	2%
Ponds	2.7	81.9	179.9	149.0	413.6	<1%
Lakes	0	17.7	100.7	33.5	151.9	<1%
Rivers	216.1	346.1	1,217.1	355.7	2,135.0	2%
Intermittent Streams (miles)	49.7	54.3	64.1	34.8	202.8	40%
Perennial Streams (miles)	64.0	54.2	72.9	115.7	306.8	60%
Uplands	17,657.4	2,251.5	19,523.1	18,432.4	57,864.5	53%
Area (acre)	27,896.9	17,362.2	32,603.5	32,147.9	110,010.6	NA
Wetland Area (acre)	10,020.7	14,665.0	11,581.7	13,177.2	49,444.6	45%

Notes:

1 Missing approximately 3,225 acres of detailed wetland mapping for Alternative 3 – diesel pipeline.
2 Note that mosaic classes calculated as 100% wetlands overestimate the wetland area proportion.
NA = Not Applicable
0 = None
ESB-SB = Ericaceous Shrub Bog – String Bog
LSB = Low Shrub Bog

Source: 3PPI et al. 2014.

Evergreen Forest Wetland, PF04B, Open Black Spruce Forest, Unnamed Tributary #2 Headwaters Tatlawiksuk River

Deciduous Forest Wetland, PF01B, Open Deciduous Forest, Deep Creek Watershed

Evergreen Scrub Shrub Wetland, PSS4B, Open Black Spruce Forest, Middle Big River Watershed

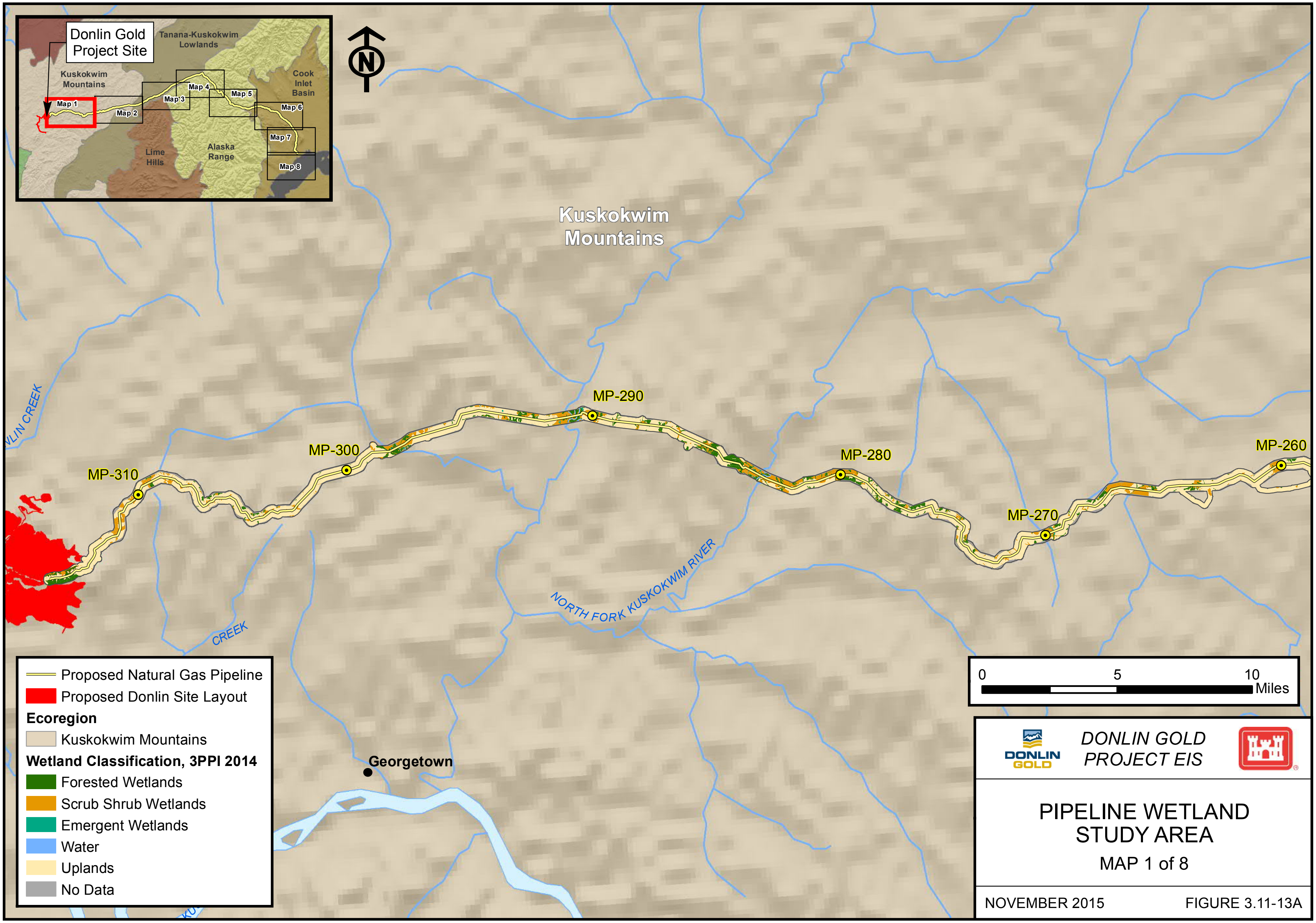
Deciduous Scrub Shrub Wetland, PSS1B, Low Shrub Bog, Canyon Lake-Skwentna River Watershed;

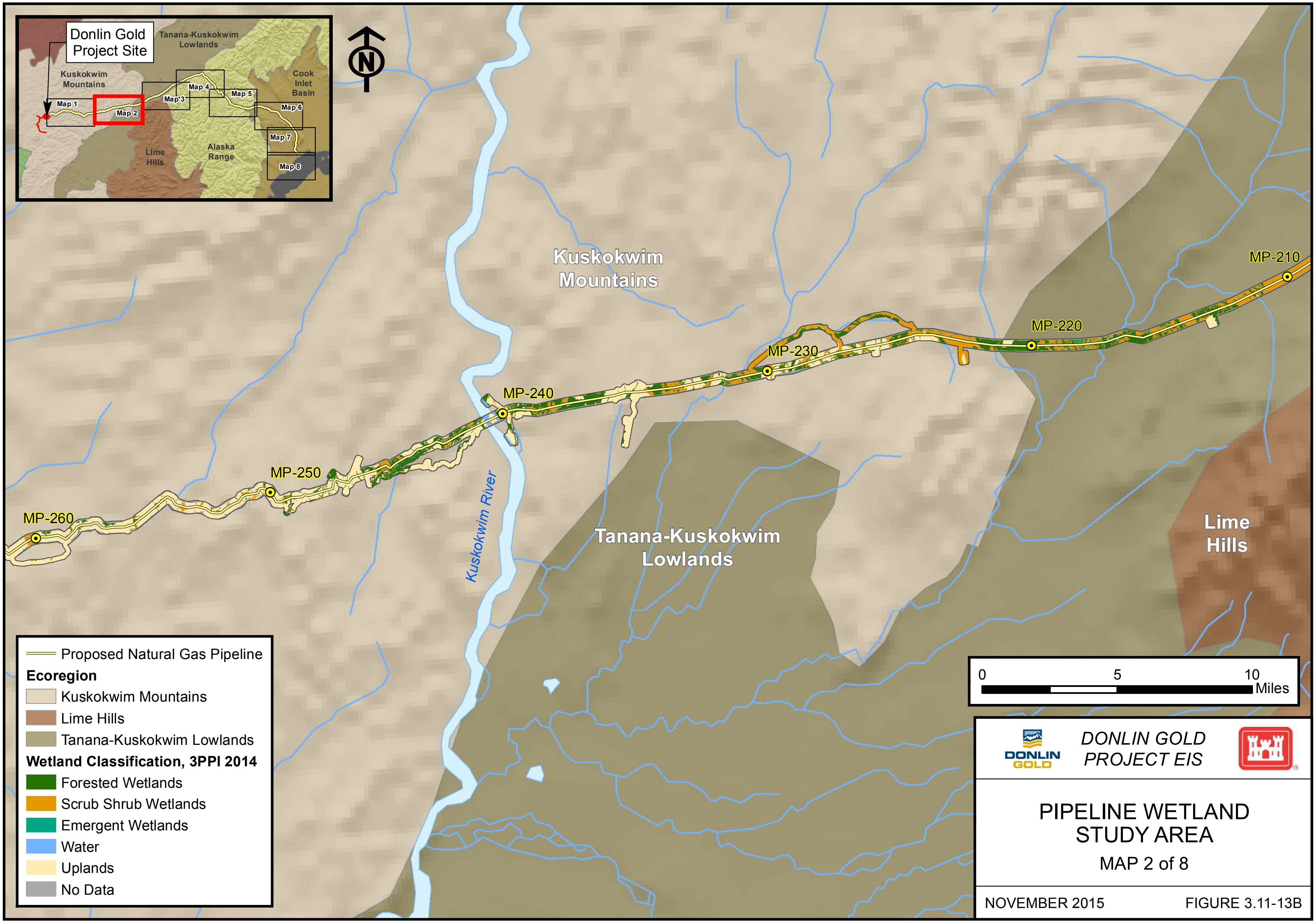
Deciduous Scrub Shrub Wetland, PSS1C, Open Alder Willow Shrub, American Creek Watershed

Herbaceous Wetland, PEM1C, Emergent Aquatic, Canyon Creek Watershed

Source: 3PPI et al. 2012; 3PPI 2014a.

Figure 3.11-12: Common Wetland Types in the Pipeline Wetland Study Area


Donlin Gold Project Site
Tanana-Kuskokwim Lowlands
Kuskokwim Mountains
Cook Inlet Basin
Lime Hills
Alaska Range
Map 1
Map 2
Map 3
Map 4
Map 5
Map 6
Map 7
Map 8
N
Kuskokwim Mountains
MP-310
MP-300
MP-290
MP-280
MP-270
MP-260
NORTH FORK KUSKOKWIM RIVER
CREEK
Georgetown
Proposed Natural Gas Pipeline
Proposed Donlin Site Layout
Ecoregion
Kuskokwim Mountains
Wetland Classification, 3PPI 2014
Forested Wetlands
Scrub Shrub Wetlands
Emergent Wetlands
Water
Uplands
No Data
0
5
10
Miles
DONLIN GOLD
DONLIN GOLD PROJECT EIS
PIPELINE WETLAND STUDY AREA
MAP 1 of 8
NOVEMBER 2015
FIGURE 3.11-13A



DONLIN GOLD PROJECT EIS

PIPELINE WETLAND STUDY AREA

MAP 2 of 8

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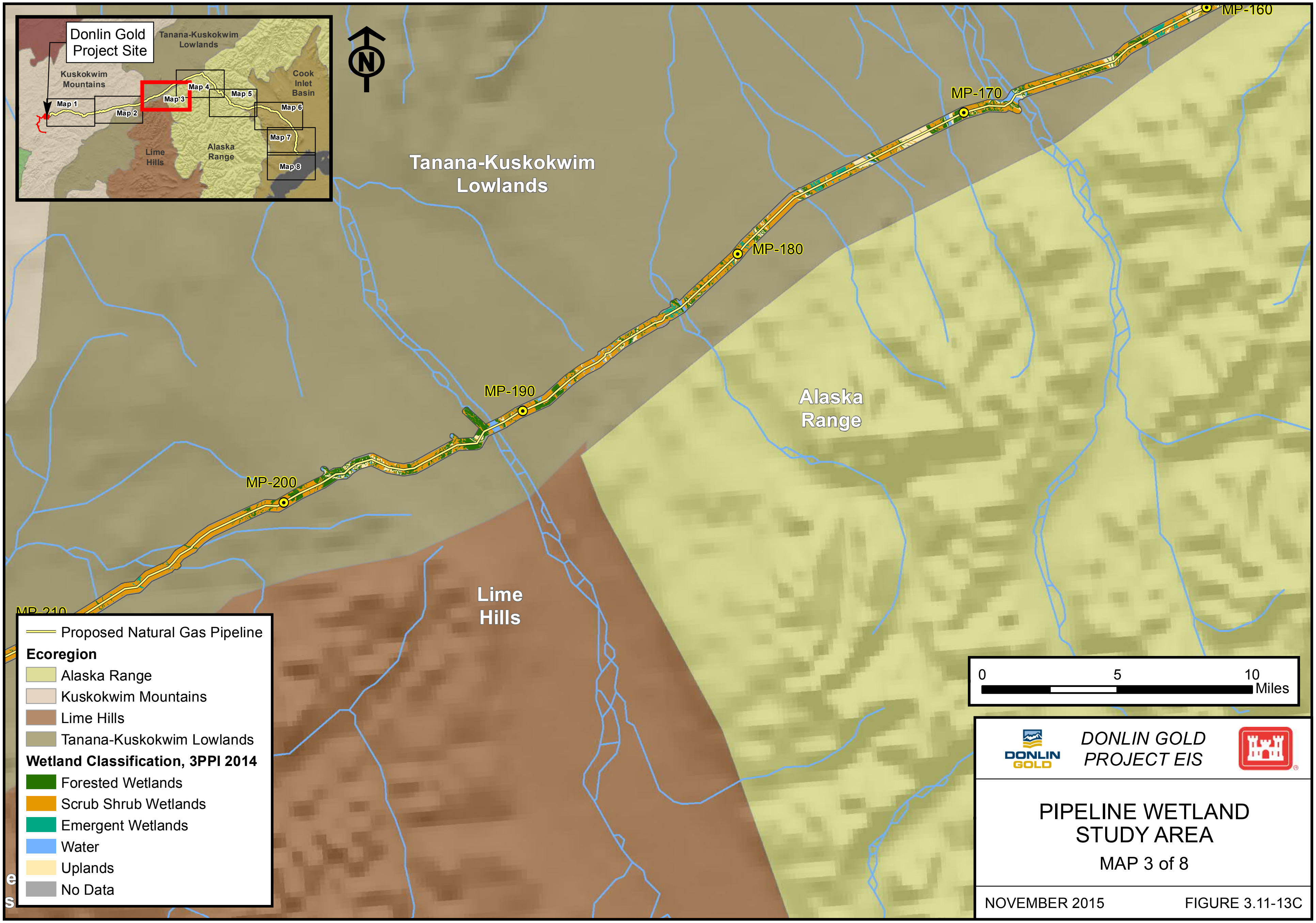
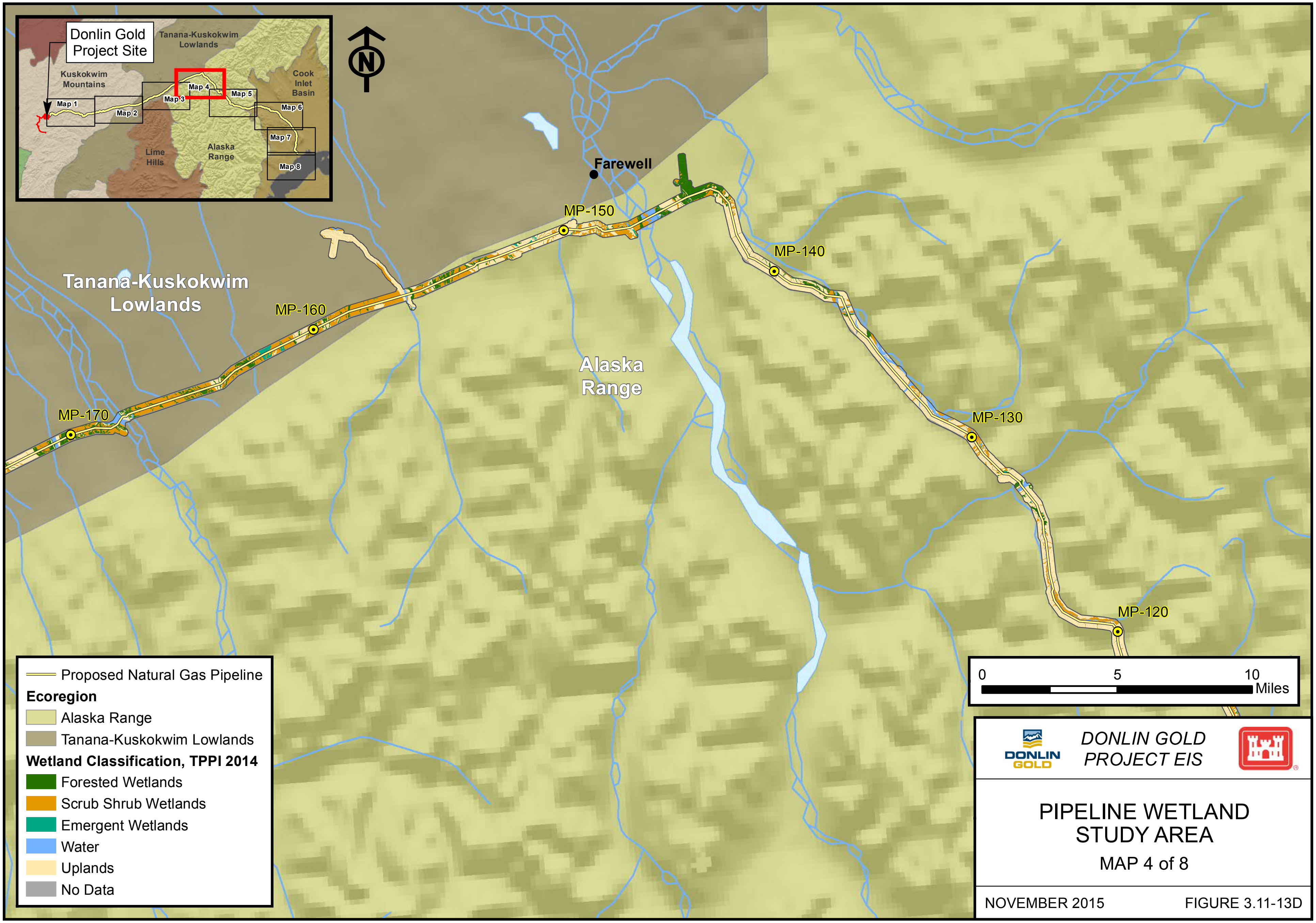
FIGURE 3.11-13B



Donlin Gold Project Site
Tanana-Kuskokwim Lowlands
Kuskokwim Mountains
Cook Inlet Basin
Map 1
Map 2
Map 3
Map 4
Map 5
Map 6
Map 7
Map 8
Lime Hills
Alaska Range
N
Tanana-Kuskokwim Lowlands
Alaska Range
Lime Hills
MP-160
MP-170
MP-180
MP-190
MP-200
MP-210
Proposed Natural Gas Pipeline
Ecoregion
Alaska Range
Kuskokwim Mountains
Lime Hills
Tanana-Kuskokwim Lowlands
Wetland Classification, 3PPI 2014
Forested Wetlands
Scrub Shrub Wetlands
Emergent Wetlands
Water
Uplands
No Data
0 5 10 Miles
DONLIN GOLD
DONLIN GOLD PROJECT EIS
PIPELINE WETLAND STUDY AREA
MAP 3 of 8
NOVEMBER 2015
FIGURE 3.11-13C

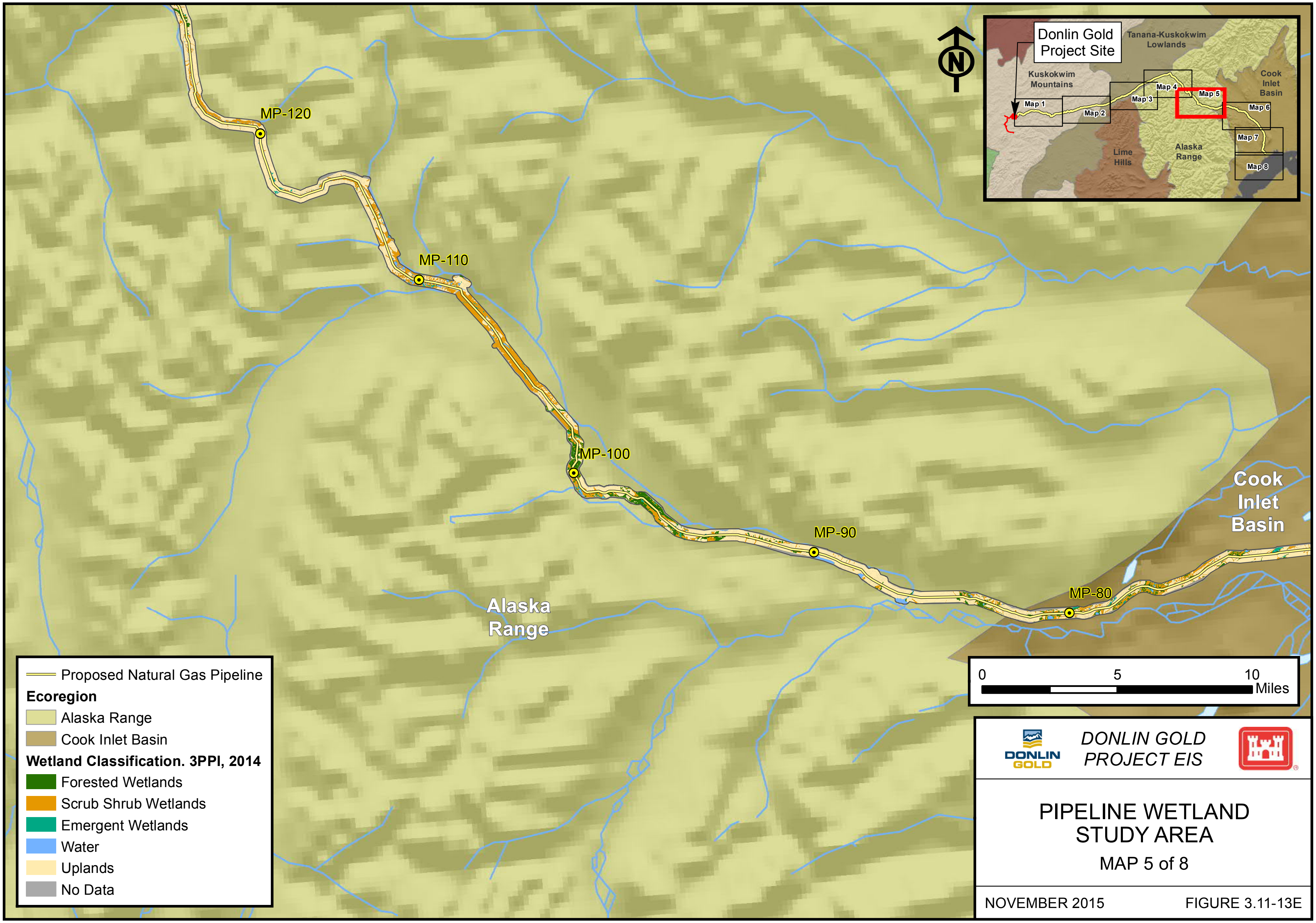


PIPELINE WETLAND STUDY AREA

MAP 4 of 8

NOVEMBER 2015

FIGURE 3.11-13D



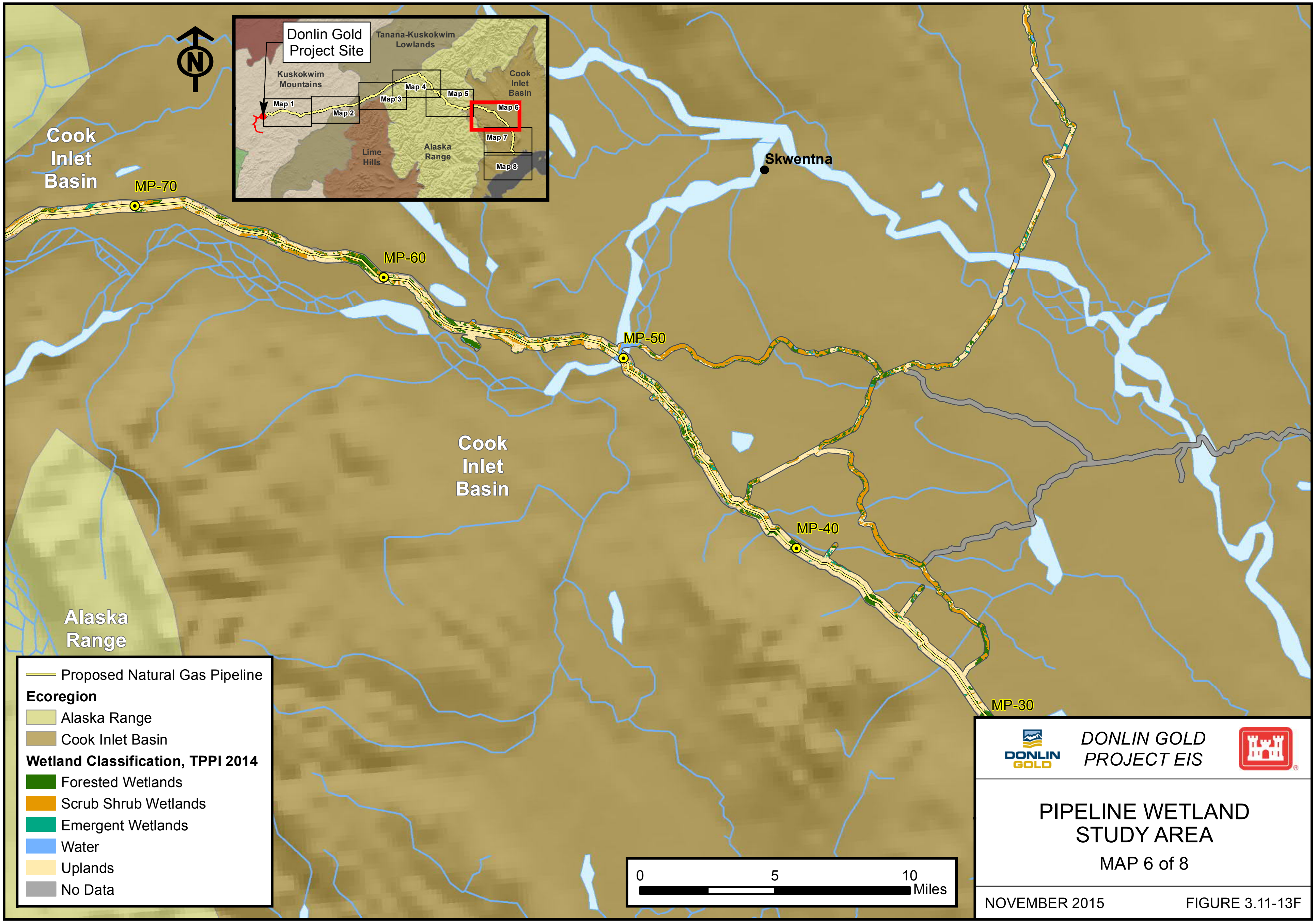
DONLIN GOLD PROJECT EIS

PIPELINE WETLAND STUDY AREA

MAP 5 of 8

NOVEMBER 2015

FIGURE 3.11-13E



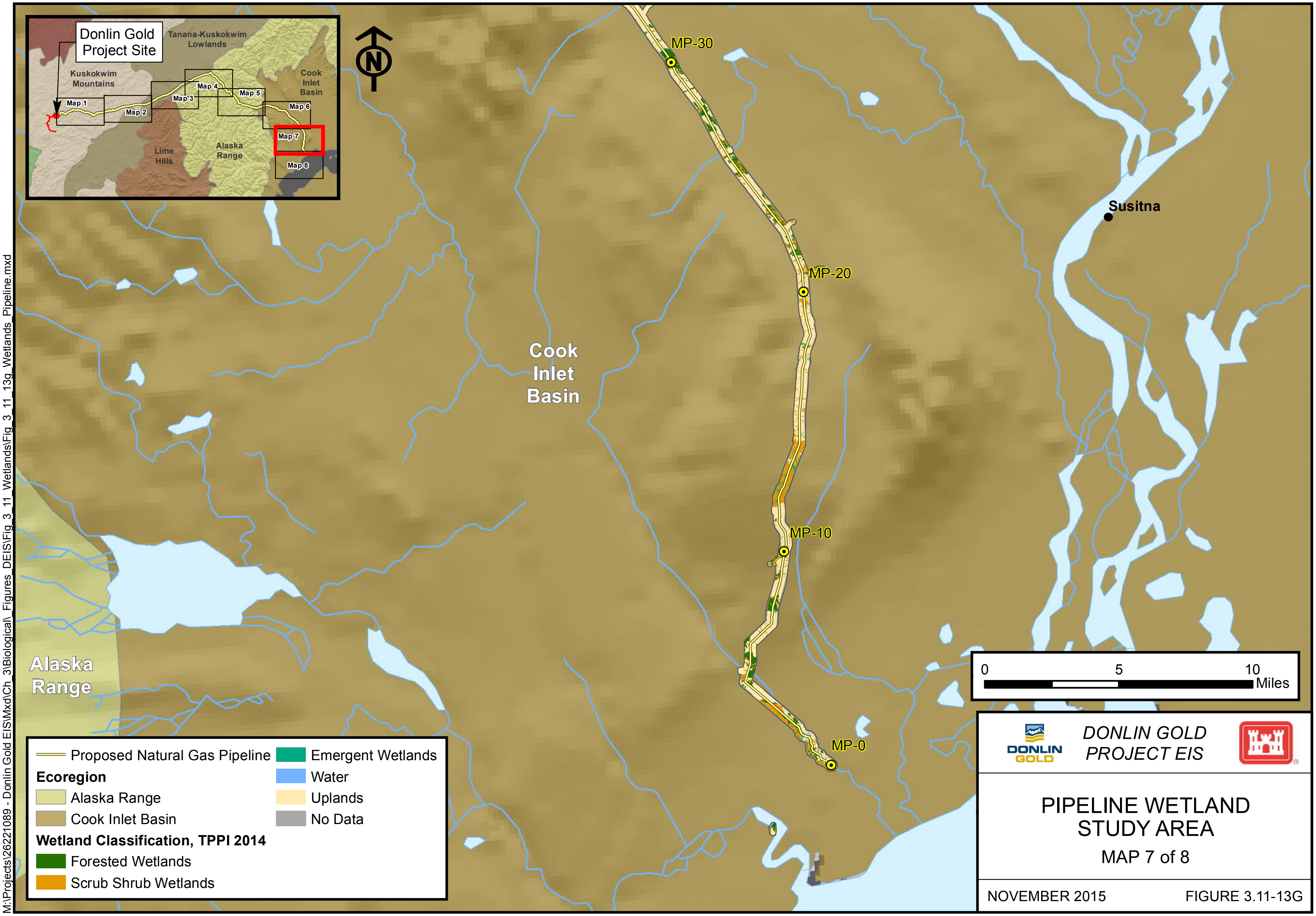
DONLIN GOLD PROJECT EIS

PIPELINE WETLAND STUDY AREA

MAP 6 of 8

NOVEMBER 2015

FIGURE 3.11-13F



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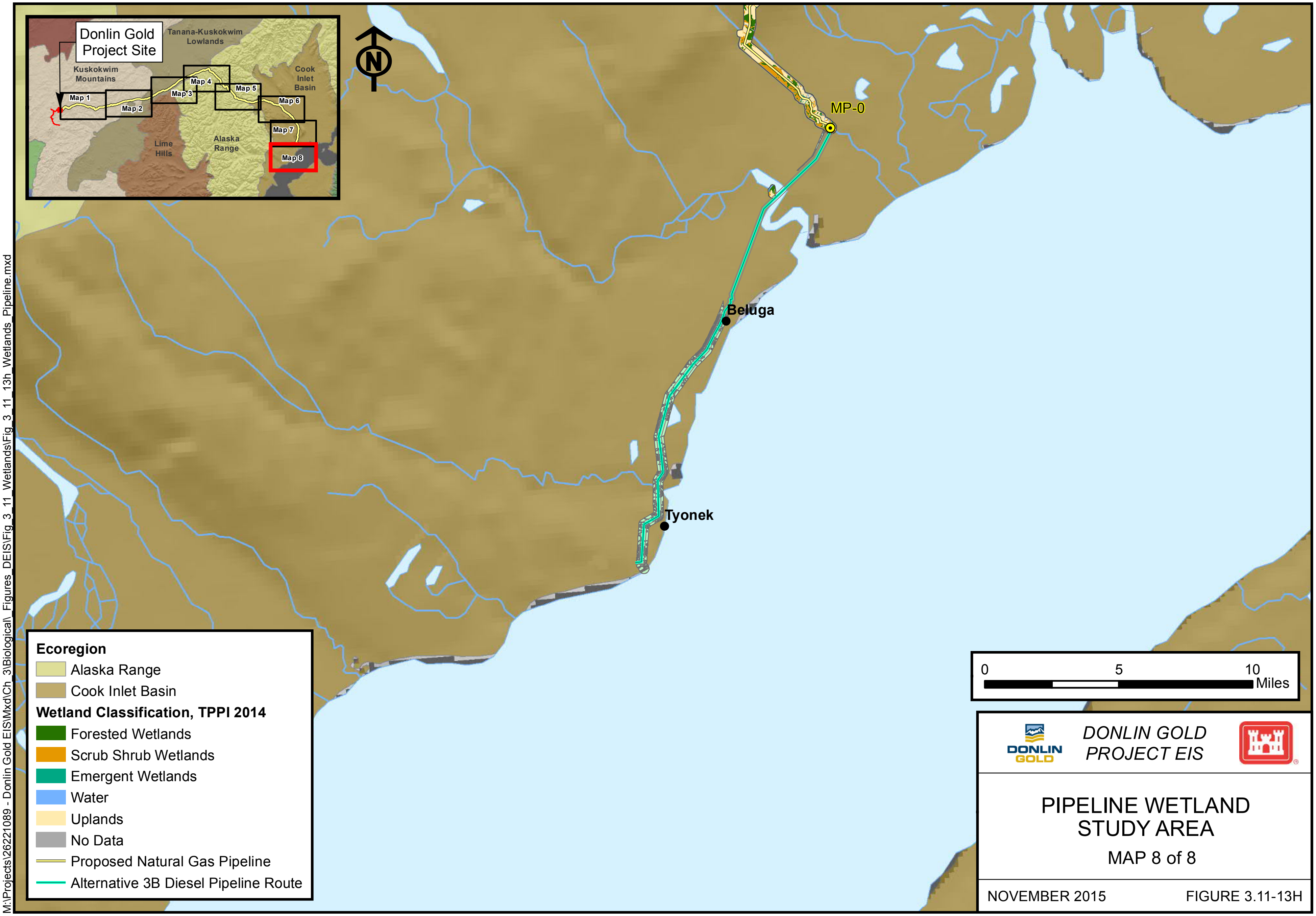

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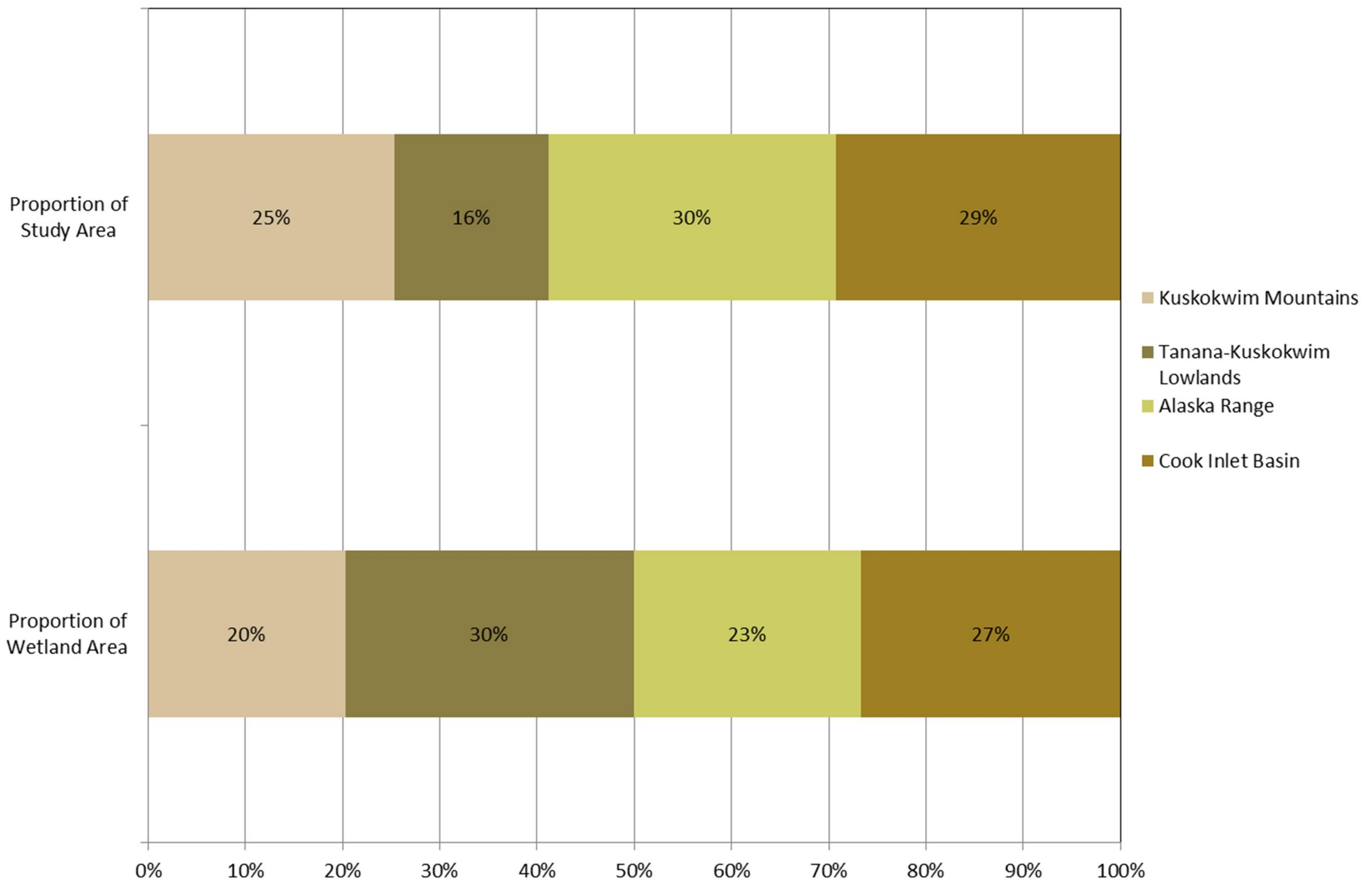
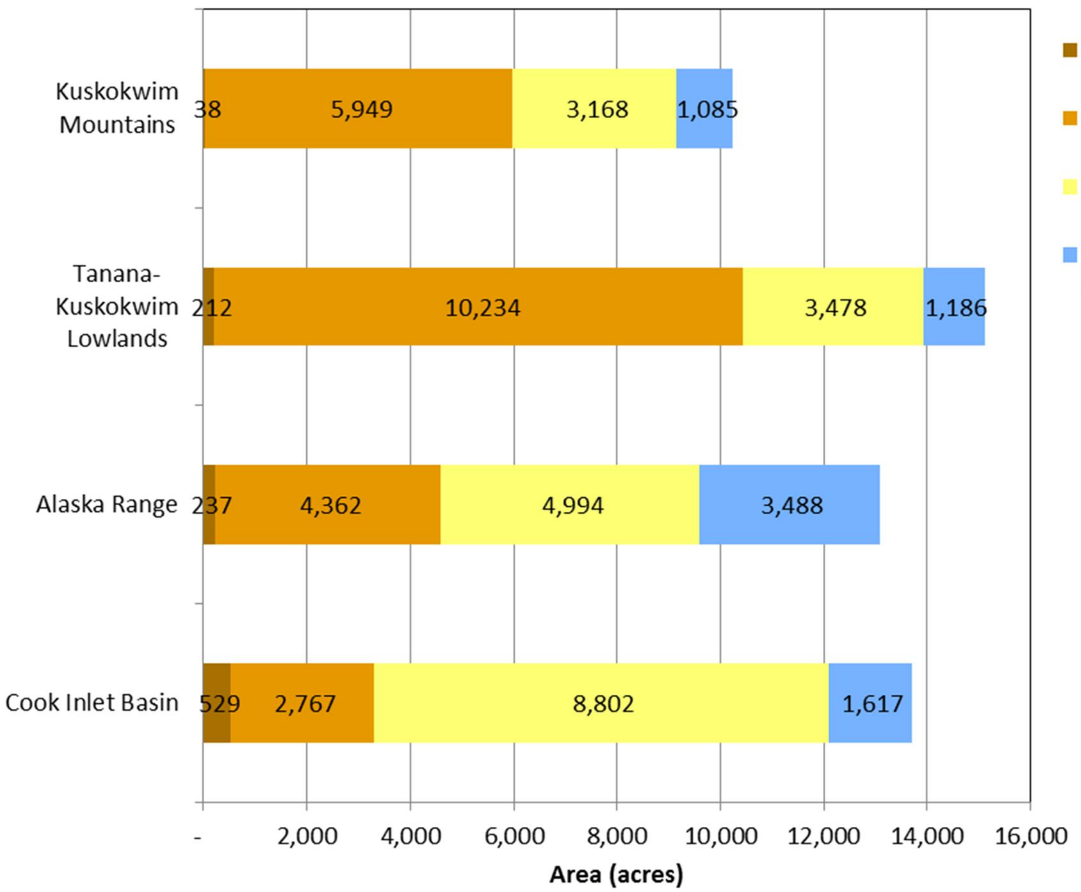


Source: 3PPI et al. 2014.

Figure 3.11-14: Pipeline Wetland Study Area and Wetland Proportions by Ecoregion



Source: 3PPI et al. 2014.

Figure 3.11-15: Pipeline Wetland Study Area Hydrogeomorphic Classes by Ecoregion

Preliminary results based on the HGM model developed by 3PPI (2014b) seem to indicate that approximately 84 percent of wetlands evaluated within the pipeline wetland study area were high-functioning wetlands (FCI ≥ 0.66) for storm and floodwater storage, approximately 98 percent for modification of water quality, approximately 98 percent for contribution to the abundance and diversity of wetland flora, and approximately 58 percent for contribution to the abundance and diversity of wetland fauna. Approximately 91 percent were modeled as moderate-functioning wetlands (FCI ≥ 0.33 and < 0.66) for modification of groundwater discharge, and approximately 82 percent for modification of groundwater recharge. Approximately 78 percent were modeled as low-functioning wetlands (FCI < 0.33) for modification of stream flow, and approximately 54 percent for export of detritus. Function varied among HGM and wetland classes (Table 3.11-12, and Appendix K, Tables K-6 and K-7; 3PPI 2014b).

Table 3.11-12: Pipeline Wetland Study Area Preliminary Wetland Function Ratings by HGM Classes

Wetland Function Models	FCI Model Rating	HGM Class					Study Area (acres)	Area[1] (%)
		Depression	Flat	Slope	Riverine	Lake Fringe		
Hydrologic Functions								
Modification of Groundwater Discharge	Low	5.9	648.5	149.9	6.7	NA	811.1	2%
	Mod	789.5	21,606.5	14,474.8	4,362.3	NA	41,233.1	91%
	High	104.4	491.5	2,356.7	307.9	NA	3,260.6	7%
Modification of Groundwater Recharge	Low	0	8.1	NA	0	0	8.1	<1%
	Mod	815.0	21,785.4	NA	212.5	7.8	22,820.7	82%
	High	30.6	469.6	NA	4,429.9	5.6	4,935.6	18%
Storm and Floodwater Storage	Low	7.3	0	2.6	0	0	10.0	<1%
	Mod	359.7	1,124.7	2,094.8	3,757.4	12.6	7,349.3	16%
	High	541.8	21,621.8	14,888.2	919.6	2.7	37,974.1	84%
Modification of Stream Flow	Low	518.3	8,412.9	9,883.9	1,937.9	0	20,752.9	78%
	Mod	187.2	889.2	1,303.6	1,343.7	0	3,723.7	14%
	High	56.0	205.3	1,432.8	555.4	0	2,249.5	8%
Biogeochemical Functions								
Modification of Water Quality	Low	50.9	0	0	17.0	0	67.9	<1%
	Mod	241.2	95.7	122.0	162.9	0	621.7	1%
	High	616.8	22,650.8	16,863.7	4,497.1	15.3	44,643.7	98%
Export of Detritus	Low	517.1	8,354.4	5,956.1	15.2	0	14,842.8	54%
	Mod	98.1	6.7	3,905.0	103.1	1.4	4,114.4	15%
	High	146.2	1,134.0	2,759.2	4,558.6	13.9	8,611.9	31%
Biological Functions								
Abundance and Diversity of Wetland Flora	Low	4.7	14.3	0.2	0	0	19.1	<1%
	Mod	285.9	388.5	166.5	124.0	0.9	965.8	2%
	High	618.3	22,356.1	16,819.0	4,553.0	14.4	44,360.8	98%
Abundance and Diversity of Wetland Fauna	Low	0	12.4	0	0	0	12.4	<1%
	Mod	822.6	9,216.6	5,144.5	3,664.6	12.7	18,861.0	42%
	High	86.3	13,529.9	11,841.2	1,012.4	2.6	26,472.3	58%

Notes:

1 Proportion of total wetland area rated for the respective function within pipeline wetland study area by Functional Capacity Index (FCI) rating (Low > 0 and < 0.33; Moderate (Mod) ≥ 0.33 and < 0.66; High ≥ 0.66). Note that mosaic classes calculated as 100% wetlands overestimate the wetland functional area.

NA = Not Applicable 0 = None 0.0 = < 0.1

Source: 3PPI 2014b.

3.11.3.4 CLIMATE CHANGE

Climate change is affecting resources in the EIS Analysis area and trends associated with climate change are projected to continue into the future. Section 3.26.2 discusses climate change trends and impacts to key resources in the physical and biological environments including atmosphere, water resources, permafrost, and vegetation. Current and future effects on wetlands are tied to changes in physical resources and vegetation (discussed in Section 3.26.3).

3.11.4 ENVIRONMENTAL CONSEQUENCES

This section describes potential impacts to wetlands as a result of the proposed Donlin Gold mine site, transportation facilities, and natural gas pipeline. Summaries of potential impacts on wetlands, both direct and indirect, follow the criteria listed in Table 3.11-13.

Table 3.11-13: Impact Criteria for Effects on Wetlands

Impact Component	Effects Summary		
Magnitude or Intensity	**Low:** Impacts to <5% by acreage of high or moderate functioning wetlands or greater proportions of low functioning wetlands in the study area[1].	**Medium:** Impacts to 5 to 25% by acreage of high or moderate functioning wetlands in the study area[1].	**High:** Impacts to >25% by acreage of high or moderate functioning wetlands in the study area[1].
Duration	**Short-term:** Wetland functions may be reduced during construction but would be expected to return to near pre-activity level within several growing seasons after restoration.	**Medium-term:** Wetland functions would be reduced during construction but could return to near pre-activity functions after the action ceased within several decades after restoration.	**Long-term:** Wetland functions would be eliminated and would not be anticipated to return to previous functions after the action that caused the impacts ceased; or within more than several decades after restoration.
Geographic Extent	**Local:** Affects wetland systems within one or a few watersheds[2].	**Regional:** Affects wetland systems across multiple watersheds[2].	**Extended:** Affects extensive wetland systems across many watersheds[2].
Context	**Common:** Affects wetlands that are widespread and typical of the region.	**Important:** Affects wetlands that support important local or regional subsistence resources.	**Unique:** Affects wetlands that are rare or of very high quality.

Notes:

Proportions are based on percentages used in the Point Thomson EIS (Section 5.8; Table 5.8-1).

1 The wetland study areas defined in Section 3.11.3 are assumed to be generally representative of affected watersheds and the surrounding area.

2 Watersheds are defined as the National Hydrography Database Hydrologic Unit Code (HUC) 10-digit watershed boundary data (HUC 10 WBD).

Based on an evaluation of these criteria, summary conclusion levels could include:

- no effect – alternative would not affect the resource;
- negligible – impacts generally extremely low in intensity, are temporary, localized, and generally do not affect unique resources;
- minor – impacts tend to be low intensity, temporary duration, and local extent, although common resources may experience more intense, longer-term impacts;

- moderate – impacts can be any intensity or duration, although common and important resources may be affected by higher intensity, longer term, or broader extent impacts (unique resources may be medium or low intensity, shorter duration or intermittent impacts over a long period at a local or regional scale); or
- major – impacts generally medium or high intensity, long-term or permanent in duration, regional or extended scope, and affect important or unique resources.

In evaluating negative and positive impacts to wetlands, direct project footprint impacts are more clearly defined than indirect impacts to ground and surface water distribution from diversions and dewatering or impacts to wetland vegetation and soils from fugitive dust deposition or erosion and sedimentation. Relevant factors for this project include:

- The location and total area of project footprints within wetland habitats. Project footprints located within wetland habitats would change or eliminate large areas of wetlands.
- The type and function of wetlands that are covered by project footprints. Project footprints within potentially rare or high-functioning wetlands may be of greater consequence than project footprints within abundant or potentially low-functioning wetlands.
- Changes to ground and surface water distribution. Project-related activities which change ground or surface water distribution could inundate or dry wetlands leading to conversion of wetlands to water or upland.
- Changes to wetland vegetation cover and soils. Project-related activities that generate fugitive dust may result in deposition within wetlands which could alter wetland vegetation cover and reduce wetland functions. Project-related activities that increase erosion or sedimentation could alter wetland vegetation cover and reduce wetland functions.

3.11.4.1 ALTERNATIVE 1 – NO ACTION

Under the No Action alternative the Donlin Gold Project would not be constructed, therefore it would not have any effects on wetlands.

3.11.4.2 ALTERNATIVE 2 – DONLIN GOLD'S PROPOSED ACTION

Potential wetland impacts specific to Donlin Gold's proposed mine site, transportation facilities, and natural gas pipeline route are described in the following sections.

3.11.4.2.1 MINE SITE– CONSTRUCTION; OPERATIONS AND MAINTENANCE; AND CLOSURE, RECLAMATION, AND MONITORING

<u>Construction; and Operations and Maintenance</u>

Primary direct and indirect construction-related effects on wetlands would include:

- clearing and removal of wetland vegetation;
- placement of fill in wetlands;

- excavation that eliminates wetlands;
- compaction, rutting, and mixing of wetland soils; and
- disruption of wetland hydrology through:
  - blocking surface water flow and creating impoundments that flood wetlands;
  - blocking or diverting surface water flow and drying wetlands;
  - breaching impervious substrates causing drainage of perched water tables and drying wetlands;
  - degrading permafrost causing drainage and drying wetlands;
  - degrading permafrost causing subsidence that converts wetlands to waters; and
  - removing, blocking, or diverting subsurface water causing drying of wetlands.

Most project-related direct and indirect effects on wetlands would be initiated during construction and may result in temporary or permanent loss of wetlands or alteration in wetland functions. Operations-related direct and indirect effects on wetlands would include:

- degradation of wetland vegetation and soils due to:
  - fugitive dust and gravel thrown from pads or roads by vehicles or snow clearing,
  - introduction and spread of invasive species,
  - riparian wetland erosion from unstable slopes or water diversions,
  - sediment deposition from slope erosion, and
  - chemical and fuel spills and leaks.
- alteration of surface water quantity or distribution due to:
  - creation of freshwater impoundments,
  - redirection of drainage through artificial drainage channels,
  - interruption of surface flow by roadways, and
  - stream diversions, snow fences, and freshwater use.
- alteration of subsurface water quantity and distribution due to:
  - excavation and dewatering wells for the open pit, and
  - creation of freshwater impoundments that intercept groundwater or increase infiltration.

Excavation of the open pit and filling within the Waste Rock and Tailings Storage facilities would occur throughout the active life of the mine. The maximum extents of all surface disturbance impacts were used to evaluate direct wetland impacts for the mine site. Some wetland reclamation would begin shortly after construction and would continue throughout operations and closure. A total of 6,967 acres of wetlands would be directly affected by Donlin Gold's proposed mine (Table 3.11-14). Mine site wetland impacts would affect primarily flat and slope HGM classes of wetlands (Table 3.11-14, and Figure 3.11-16).

Table 3.11-14: Alternative 2 Mine Site Preliminary Calculation of Wetland Direct Impacts from Construction, and Operations and Maintenance

Wetland Category	HGM Class (acres)					Impact Area (acres)	Study Area (acres)	Area[1] (%)
	Depression	Flat	Slope	Riverine	River Channel			
Evergreen Forested Wetlands	0	3,904.4	417.3	81.2	0	4,402.9	17,537.9	25%
Deciduous Forested Wetlands	0	0	1.0	0.3	0	1.2	235.0	1%
Mixed Forested Wetlands	0	39.5	325.0	1.9	0	366.4	2,110.4	17%
Evergreen Scrub Shrub Wetlands	0	1,399.7	213.5	25.9	0	1,639.2	7,905.7	21%
Deciduous Scrub Shrub Wetlands	0.3	284.2	189.4	42.9	0	516.9	4,713.1	11%
Herbaceous Wetlands	2.4	6.1	30.0	1.5	0	40.1	413.8	10%
Ponds	0.1	0	0	1.0	0	1.1	35.8	3%
Rivers	0	0	0	0	0.5	0.5	317.0	<1%
Intermittent Streams (miles)	NA	NA	NA	NA	NA	13.4	49.9	27%
Perennial Streams (miles)	NA	NA	NA	NA	NA	28.7	133.2	22%
Uplands	NA	NA	NA	NA	NA	2,043.0	7,222.6	28%
Area (acre)	2.9	5,634.0	1,176.2	154.7	0.5	9,011.2	40,491.2	22%
Wetland Area (acre, %)	<1%	81%	17%	2%	<1%	6,966.7	32,915.8	21%

Notes:

1 Proportion of Impact Area within Mine Site Wetland Study Area by Wetland Category. Note that mosaic classes calculated as 100% wetlands overestimates the wetland area proportion.

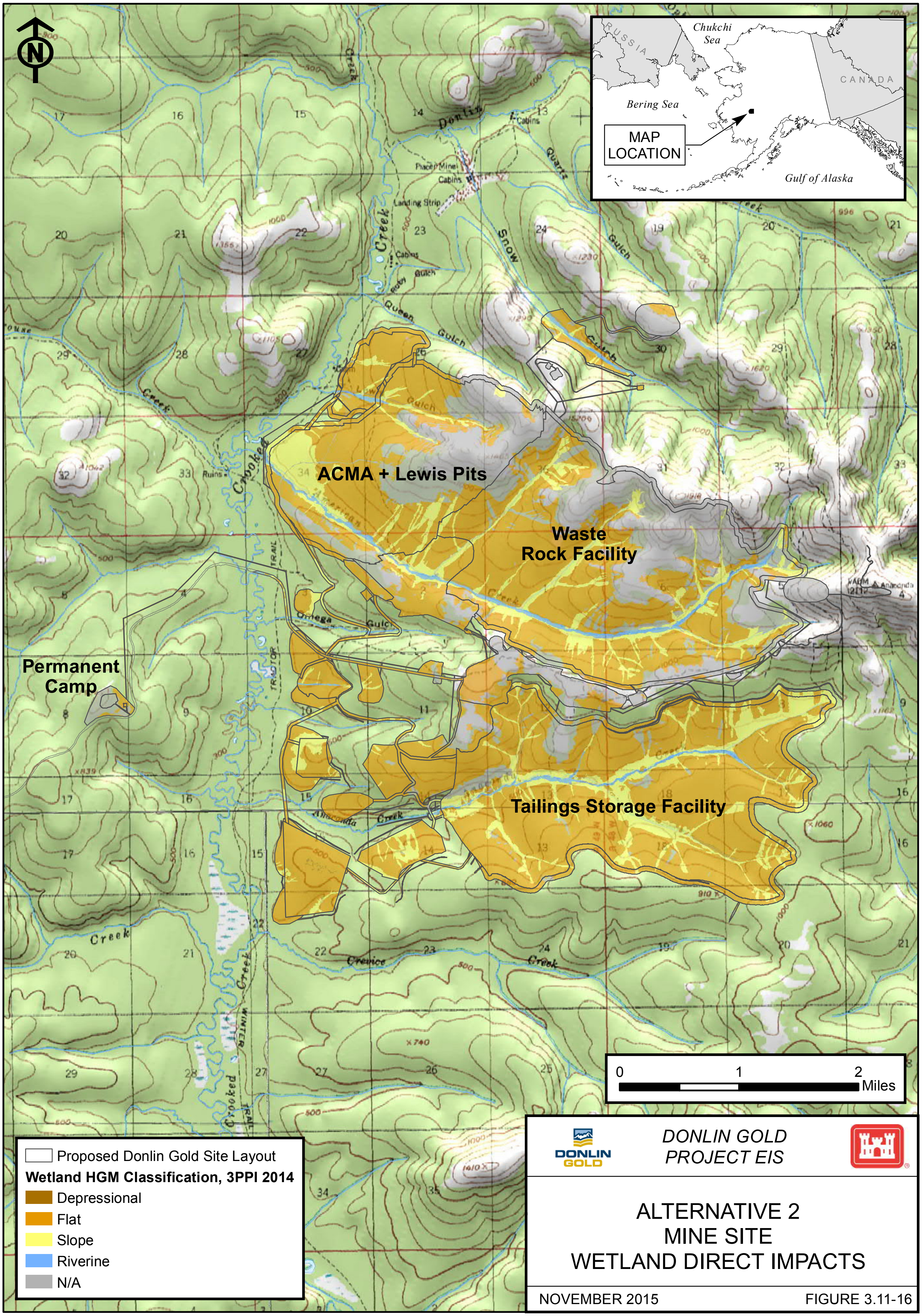
NA = Not Applicable
0 = None
0.0 = < 0.1

Source: 3PPI et al 2014.

Of the 6,967 acres of wetlands that would be affected by the proposed mining activities, several hundred acres have been previously disturbed by historic and ongoing exploration and placer mining activities (3PPI et al. 2014). A large proportion of the 40 acres of herbaceous wetlands that would be affected by the mine has been previously disturbed, as have many of the 517 acres of deciduous scrub shrub wetlands (3PPI et al. 2014). Facilities have been sited to avoid and minimize wetland impacts and allow for efficient reclamation of disturbed areas.

Excavation, filling, and clearing of wetlands and waters in the American Creek, Snow Gulch, Omega Gulch, Anaconda Creek, and Crooked Creek watersheds would alter or remove their capacity to provide hydrologic, biogeochemical, and biological functions. Construction-related disturbances could alter wetland modification of groundwater functions (recharge and discharge), and would decrease storm and floodwater storage and modification of stream flow functions by decreasing the wetlands' potential to dissipate energy and reduce peak flows. Between 10 and 35 percent of the mine site study area wetlands that are rated high for any of these hydrologic functions would be altered by mine construction (Table 3.11-15, Appendix K, Tables K-8, and K-9; 3PPI 2014b). These altered hydrologic functions would extend to the streams connected to or downstream from the affected wetlands. A total of 42 miles of streams would be directly affected by construction, including 29 miles of perennial streams and 13 miles of intermittent streams (Table 3.11-14; 3PPI et al. 2014), see Section 3.5, Surface Water Hydrology, for a discussion of surface water hydrology impacts.

Construction on or through wetlands would decrease or remove the wetlands' potential to improve water quality by preventing erosion and by settling sediments. Sediment barriers and erosion control planning would mitigate for loss of this wetland function. Clearing with no ground disturbance was preliminarily modeled to reduce the modification of water quality biogeochemical function by 11 to 17 percent and to reduce the contribution to the abundance and diversity of wetland fauna by 17 to 18 percent depending on the wetland HGM class; but was not modeled to reduce the export of detritus or contribution to the abundance and diversity of wetland flora functions based on expected changes in the variables used to model these functions (3PPI 2014b). Wetlands affected by mine construction seem to include 19 to 37 percent, depending on the function, of the high functioning wetlands for these biogeochemical and biological functions (Table 3.11-15). Wetland vegetation clearing that includes some ground disturbance and compaction was preliminarily modeled to reduce the modification of water quality function by 11 to 17 percent, the contribution to the abundance and diversity of wetland fauna by 19 to 21 percent, and was modeled to reduce all hydrologic functions by 3 to 7 percent, with the level of effect dependent on the wetlands HGM class (3PPI 2014b). Wetlands affected by mine construction seem to include 10 to 35 percent, depending on the function, of wetlands rated as high functioning for hydrologic functions (Table 3.11-15).



DONLIN GOLD PROJECT EIS

ALTERNATIVE 2
MINE SITE
WETLAND DIRECT IMPACTS

NOVEMBER 2015

FIGURE 3.11-16

Dust emissions generated by drilling and blasting, waste rock and ore loading and unloading, traffic on roads, wind erosion of exposed surfaces and ore processing (Environ 2014a) would be deposited primarily downwind from sources on nearby vegetation and wetlands. Most dust would be produced by the pit and Waste Rock Facility (WRF) (Environ 2014a). Operations contributing to total site dust at mineral extraction sites include: drilling and blasting, loading and dumping, draglines, crushing and preparation, conveyors, haulage roads, and storage piles (Petavratzi et al. 2005). Most dust generated during minerals operations is over 30 µm in size most dust of this size would be deposited within 328 feet or 100 m (Petavratzi et al. 2005).

Prevailing winds from the southeast or north (Air Sciences, Inc. 2014a) would likely transport most fugitive dust created during mine construction and operations to the northwest or south. Section 3.2 Soils estimates the amount of dust that is predicted to be deposited on soils at the mine site on a watershed basis, and discusses the potential for dust deposition to alter soil pH. The wetland area potentially affected by dust deposition sufficient to cause changes in wetland vegetation may extend as far as 328 feet (100 m), with the heaviest unmitigated deposition expected to occur within 33 feet (10 m) for traffic on gravel roads (Walker and Everett 1987; Hasselbach et al. 2005).

Areas most likely to be affected by dust generated during mine construction and operations could include uplands and wetlands northwest of the pit and WRF, near the ore storage area and along haul routes between the pit, storage, and processing areas. An estimated wetland area of 1,954 acres within 328 feet of the mine footprint could be exposed to fugitive dust during mine operations Table 3.11-16). Wetland areas exposed to dust deposition can experience vegetation community changes, reduced productivity from dust coating vegetation surfaces, mineralization of wetland soils, and potential alteration of pH (Walker and Everett 1987, Auerbach et al. 1997, Myers-Smith et al. 2006). Dust deposition reduces wetland biogeochemical and biological functions by reducing overall plant productivity, abundance, and diversity (Auerbach et al. 1997); although wetland plants and mosses may continue to assist with modification of water quality by adsorption and absorption of heavy metals (Hasselbach et al. 2005). Approximately 6 to 10 percent of the mine site study area wetlands that were preliminarily modeled as high functioning for biogeochemical or biological functions may be altered by dust deposition (Table 3.11-17, 3PPI 2014b). Dust control measures would include use of water trucks to spray roads and work areas, dust baghouses at ore transfer points, and containment of the course ore stockpile.

During construction and operations surface waters would be used, stored, and diverted within the Snow Gulch, American Creek, and Anaconda Creek watersheds as described in Section 3.5, Surface Water Hydrology. Diversion dams would reduce available surface water for wetlands downslope from the dams. During construction all three watersheds would have reduced discharge to Crooked Creek. During operations, surface waters would be used in the processing plant and various other uses and there would be an overall reduction in stream flow with the exception of Omega Gulch. Little to no flow from the American Creek watershed would reach Crooked Creek. The Tailings Storage Facility (TSF) would occupy most of the Anaconda Creek watershed, which would contain most surface water within the facility. The Snow Gulch dam would reduce available surface water by about 14 percent (see Section 3.5, Surface Water Hydrology). These changes in surface water distribution and abundance would result in some wetlands potentially drying while others would be inundated or become wetter. Drying of wetlands tends to favor development of shrubs and trees, while increased wetness tends to favor sedges and herbaceous plants (ADEC 1999; Murphy et al. 2009; Churchill 2011).

Table 3.11-15: Alternative 2 Mine Site Preliminary Calculation of Wetland Direct Impacts from Construction, and Operations and Maintenance by Preliminary Wetland Function Ratings

Wetland Function Models	FCI Model Rating	Impact Area (acres)	Study Area (acres)	Area[1] (%)	Impact Criteria (Magnitude)
Hydrologic Functions					
Modification of Groundwater Discharge	Low	66.6	491.1	14%	Medium
	Mod	6,560.5	31,380.1	21%	Medium
	High	242.0	721.8	34%	High
Modification of Groundwater Recharge	Low	0	0	NA	NA
	Mod	5,431.5	24,286.1	22%	Medium
	High	240.2	2,378.3	10%	Medium
Storm and Floodwater Storage	Low	22.5	39.0	58%	High
	Mod	491.9	2,818.3	17%	Medium
	High	6,435.9	30,055.4	21%	Medium
Modification of Stream Flow	Low	945.1	18,853.2	5%	Medium
	Mod	404.5	1,166.2	35%	High
	High	154.5	440.3	35%	High
Biogeochemical Functions					
Modification of Water Quality	Low	81.2	347.0	23%	Medium
	Mod	32.7	985.7	3%	Low
	High	6,836.4	31,580.0	22%	Medium
Export of Detritus	Low	820.0	16,236.8	5%	Medium
	Mod	95.9	1,211.8	8%	Medium
	High	551.4	2,964.5	19%	Medium
Biological Functions					
Abundance and Diversity of Wetland Flora	Low	99.1	350.9	28%	High
	Mod	462.0	1,087.0	43%	High
	High	6,406.7	31,506.2	20%	Medium
Abundance and Diversity of Wetland Fauna	Low	98.6	351.1	28%	High
	Mod	2,167.5	19,992.6	11%	Medium
	High	4,701.6	12,600.4	37%	High

Notes:

1 Proportion of Impact Area within Mine Site Study Area by Functional Capacity Index (FCI) rating (Low > 0 and < 0.33; Moderate (Mod) ≥ 0.33 and < 0.66; High ≥ 0.66). Note that mosaic classes calculated as 100% wetlands overestimates the wetland area.

NA =Not Applicable
0 = None
0.0 =< 0.1

Source: 3PPI 2014b

Table 3.11-16: Alternative 2 Mine Site Preliminary Calculation of Wetland Potential Indirect Impacts from Dust

Wetland Category	Indirect Dust Impacts[1] – HGM Class (acres)						Study Area (acres)	Area[2] (%)
	Depression	Flat	Slope	Riverine	River Channel	Total		
Evergreen Forested Wetlands	0	931.7	85.6	9.4	0	1,026.6	17,537.9	6%
Deciduous Forested Wetlands	0	0	0.8	0	0	0.8	235.0	<1%
Mixed Forested Wetlands	0	4.3	74.4	12.1	0	90.8	2,110.4	4%
Evergreen Scrub Shrub Wetlands	0	547.4	136.8	0.4	0	684.5	7,905.7	9%
Deciduous Scrub Shrub Wetlands	0.1	61.6	46.1	34.7	0	142.5	4,713.1	3%
Herbaceous Wetlands	1.0	0.3	6.0	1.3	0	8.6	413.8	2%
Ponds	0.1	0	0	0.7	0	0.7	35.8	2%
Rivers	0	0	0	0	3.0	3.0	317.0	1%
Intermittent Streams (miles)	NA	NA	NA	NA	NA	1.3	13.4	10%
Perennial Streams (miles)	NA	NA	NA	NA	NA	1.9	28.7	7%
Uplands	NA	NA	NA	NA	NA	650.9	7,222.6	9%
Area (acre)	1.1	1,545.2	349.7	58.6	3.0	2,608.4	40,491.2	6%
Wetland Area (acre, %)	<1%	79%	18%	3%	<1%	1,953.9	32,915.8	6%

Notes:

1 Potential indirect impact area within 328 feet (100 meters) around mine site footprints impact areas due to dust deposition on vegetation. These areas would overlap with areas also affected by dewatering. Excludes overlapping indirect impact area for the mine access road.

2 Proportion of indirect impact area within mine site study area by wetland category. Note that mosaic classes calculated as 100% wetlands overestimates the wetland area.

NA = Not Applicable
0 = None
0.0 = < 0.1

Source: 3PPI et al. 2014.

Table 3.11-17: Alternative 2 Mine Site Wetland Functions for Areas of Potential Indirect Impacts from Dust

Wetland Function Models	FCI Model Rating	Potential Impact Area (acres)	Study Area (acres)	Area[1] (%)	Impact Criteria (Magnitude
Hydrologic Functions					
Modification of Groundwater Discharge	Low	19.7	491.1	4%	Low
	Mod	1,837.0	31,380.1	6%	Medium
	High	70.1	721.8	10%	Medium
Modification of Groundwater Recharge	Low	0	0	NA	NA
	Mod	1,476.3	24,286.1	6%	Medium
	High	77.8	2,378.3	3%	Low
Storm and Floodwater Storage	Low	2.1	39.0	5%	Medium
	Mod	127.2	2,818.3	5%	Medium
	High	1,818.0	30,055.4	6%	Medium
Modification of Stream Flow	Low	323.1	18,853.2	2%	Low
	Mod	101.0	1,166.2	9%	Medium
	High	54.7	440.3	12%	Medium
Biogeochemical Functions					
Modification of Water Quality	Low	20.9	347.0	6%	Medium
	Mod	11.2	985.7	1%	Low
	High	1,915.3	31,580.0	6%	Medium
Export of Detritus	Low	283.3	16,236.8	2%	Low
	Mod	27.7	1,211.8	2%	Low
	High	169.5	2,964.5	6%	Medium
Biological Functions					
Abundance and Diversity of Wetland Flora	Low	27.7	350.9	8%	Medium
	Mod	133.8	1,087.0	12%	Medium
	High	1,793.0	31,506.2	6%	Medium
Abundance and Diversity of Wetland Fauna	Low	27.7	351.1	8%	Medium
	Mod	622.2	19,992.6	3%	Low
	High	1,304.6	12,600.4	10%	Medium

Notes:

1 Proportion of reclaimed area within impact area by Functional Capacity Index (FCI) rating (Low > 0 and < 0.33; Moderate (Mod) ≥ 0.33 and < 0.66; High ≥ 0.66). Note that mosaic classes calculated as 100% wetlands overestimates the wetland area.

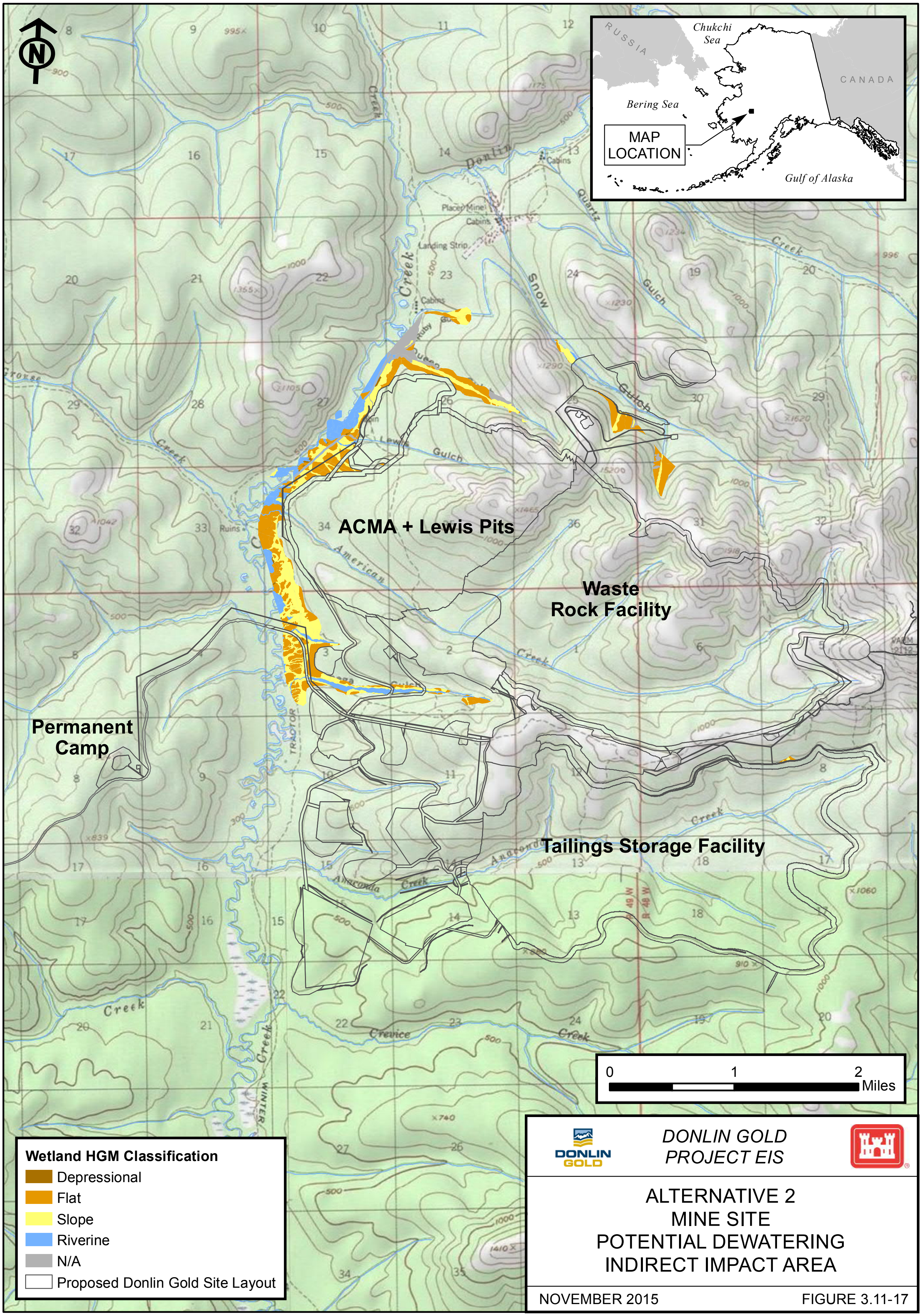
NA = Not Applicable
0 = None
0.0 = < 0.1

Source: 3PPI 2014b.

Dewatering the pit during mining would create a drawdown cone that would potentially lower the water table from 0.1 foot around the periphery to over 1,500 feet near the center of the pit over an area of about 16 square miles (ARCADIS 2013a; BGC 2015b; Figure 3.11-17). Changes in surface and subsurface water levels due to excavation of the pit and subsequent dewatering during active mining operations would potentially alter the function of wetlands in the area surrounding the mine. The maximum drawdown area was used to predict temporary indirect impacts that could occur after multiple years of mining and pit dewatering. As discussed in Section 3.5, Surface Water Hydrology, the expression of the drawdown in Crooked Creek stream flow at American Creek would primarily be during winter when a maximum of 24 percent under average flow conditions to 67 percent under average flow with high groundwater conductivity reduction in winter steam flow. Average annual Crooked Creek stream flows would be reduced by 12 to 22 percent at the maximum extent of drawdown after 20 years of active mining under average flow conditions dependent. The amount of stream flow reduction would depend on both precipitation conditions (wet versus dry years) and bedrock hydraulic conductivity, and would be much less downstream of Crevice Creek due to the addition of tributary flows. Wetlands are primarily defined by soil moisture during the growing season, when the drawdown effects are likely to be moderated by precipitation. The analysis does not incorporate the contribution to wetland hydrology from snow melt, precipitation, and the redistribution of surface water flows. Although growing season conditions may be drier, near-surface groundwater from spring runoff and precipitation may continue to support wetlands such that the overall long-term effect of the drawdown on surrounding wetlands are difficult to accurately predict.

Outside of the impacts in the direct mine footprint, a total of 541 acres of wetlands fall within and could be affected by the maximum lowered groundwater level that would occur near the end of mine operations (Table 3.11-18, and Figure 3.11-17). All wetlands within this drawdown area are unlikely to be permanently altered; the primary potential for impact is likely to be alteration of hydrologic functions, although the level of this potential alteration is unclear. Hydrologic functions that may be reduced in these wetlands during active pit dewatering could include modification of groundwater discharge and modification of stream flow. Within this drawdown area 69 acres (13 percent) of wetlands are rating high functioning for groundwater discharge, and 44 acres (8 percent) are rated high functioning for modification of stream flow (Table 3.11-19, Figure 3.11-18 and Figure 3.11-19). Wetlands with high functional capacity for these two hydrologic functions are primarily deciduous scrub shrub and evergreen forested wetlands located along drainages (Table 3.11-19). After active mining ceases pit dewatering would be discontinued, the pit would fill with water, and a new equilibrium subsurface water level would become established.

Wetland response to water level fluctuations may include both short- (5 years) and long- (45 years) term changes in vegetation communities and shifts between above and below ground productivity (Weltzin et al. 2000; Murphy et al. 2009; Churchill 2011). Woody plants increased and sedges decreased with drying conditions in boreal wetlands (Churchill 2011); while flooding increased bryophyte and decreased shrub production in bogs, and increased graminoid and forb production in fens (Weltzin et al. 2000; Murphy et al. 2009; Churchill 2011). Areas where the water table is at or near the ground surface occur beneath intermittent and perennial stream drainages at the mine site (Figure 3.11-20). Potential lowering of the water table in these areas may favor development of trees and shrubs at the expense of wetland sedges, forbs, and species richness (ADEC 1999; Murphy et al. 2009; Churchill 2011).

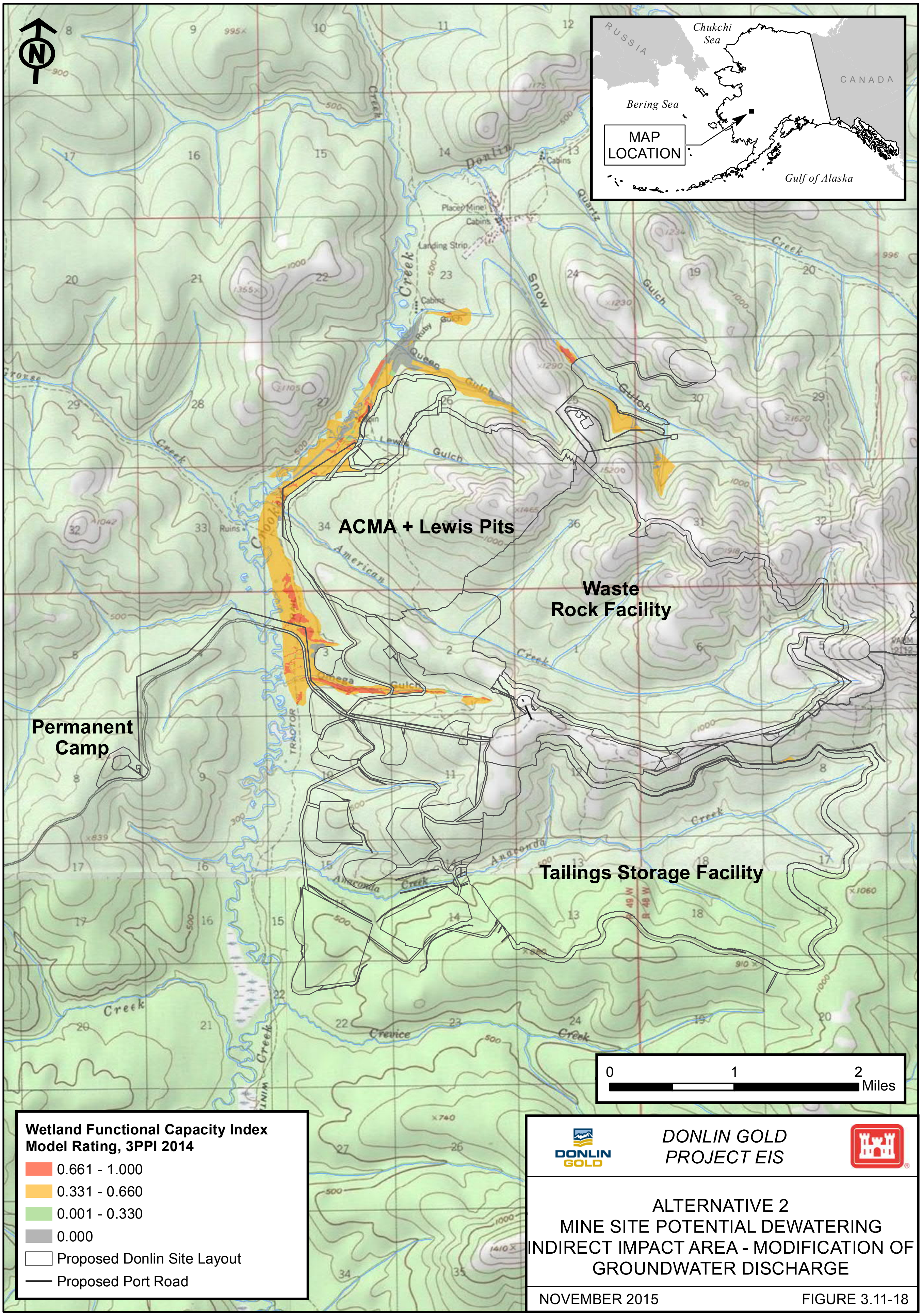


DONLIN GOLD PROJECT EIS

ALTERNATIVE 2
MINE SITE
POTENTIAL DEWATERING
INDIRECT IMPACT AREA

NOVEMBER 2015

FIGURE 3.11-17

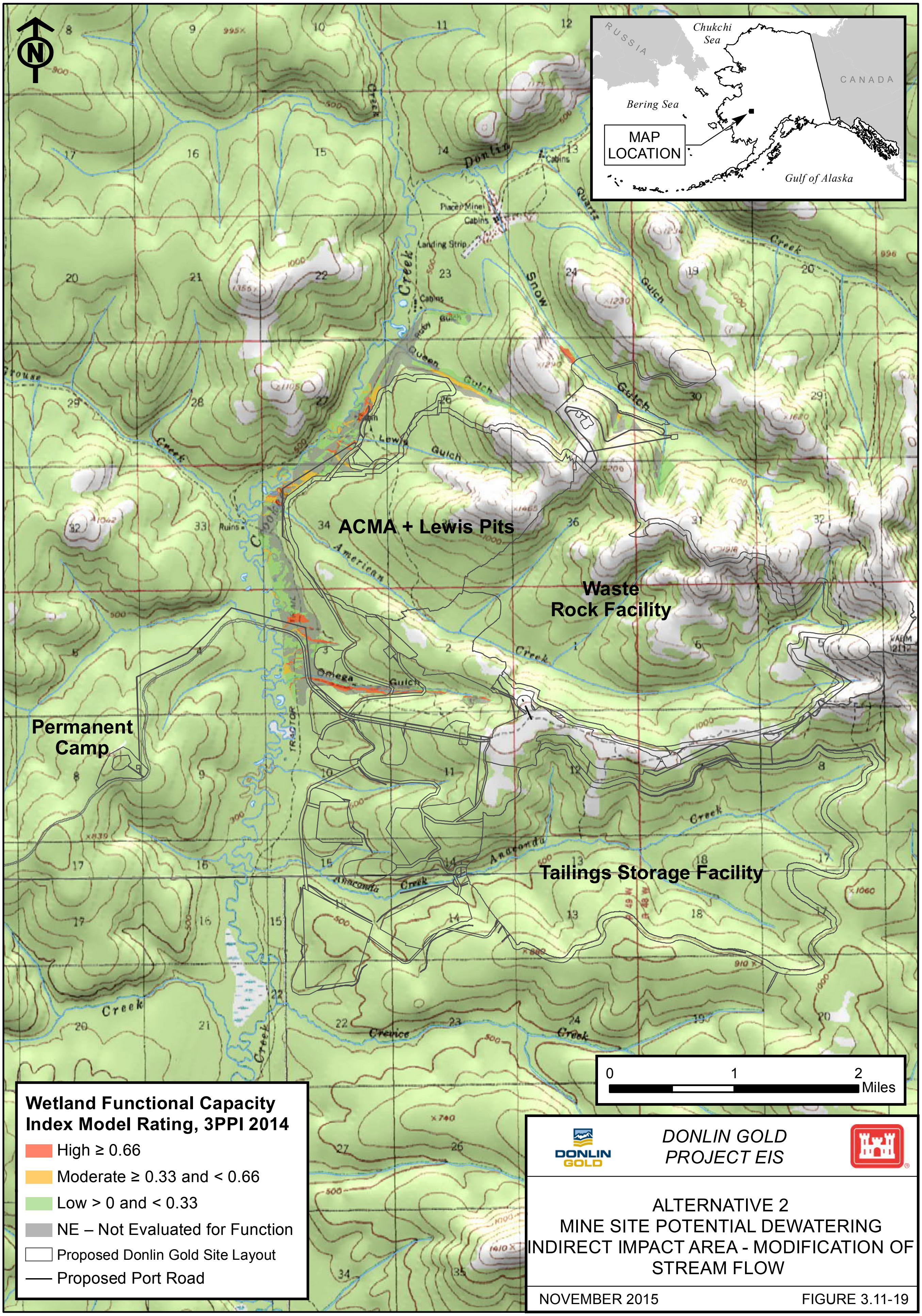


DONLIN GOLD
PROJECT EIS

ALTERNATIVE 2
MINE SITE POTENTIAL DEWATERING
INDIRECT IMPACT AREA - MODIFICATION OF
GROUNDWATER DISCHARGE

NOVEMBER 2015

FIGURE 3.11-18

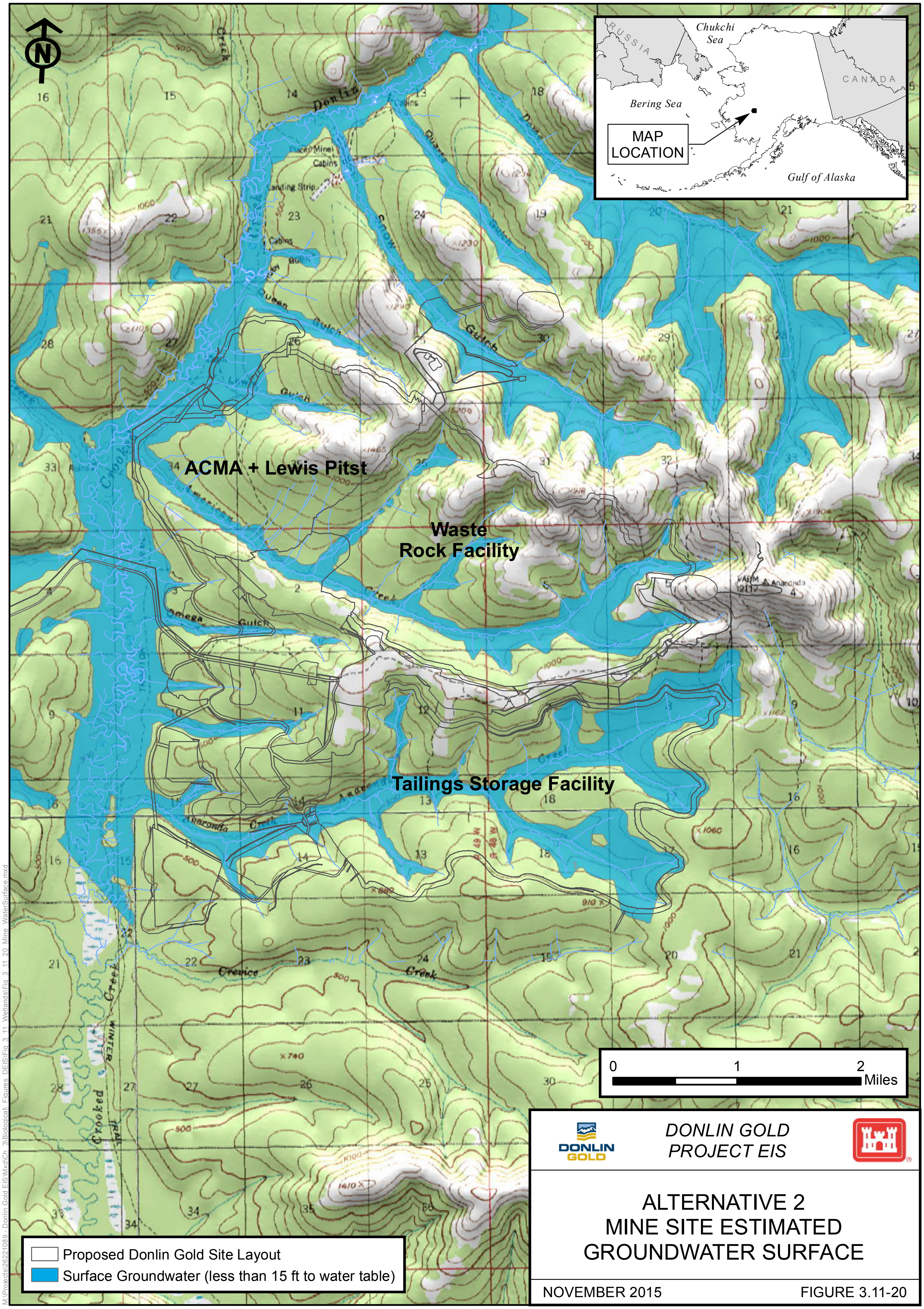


DONLIN GOLD PROJECT EIS

ALTERNATIVE 2
MINE SITE POTENTIAL DEWATERING INDIRECT IMPACT AREA - MODIFICATION OF STREAM FLOW

NOVEMBER 2015

FIGURE 3.11-19



DONLIN GOLD PROJECT EIS

ALTERNATIVE 2
MINE SITE ESTIMATED
GROUNDWATER SURFACE

NOVEMBER 2015

FIGURE 3.11-20

Table 3.11-18: Alternative 2 Mine Site Potential Dewatering Preliminary Calculation of Wetland Indirect Impacts

Wetland Category	Drawdown HGM Classes (acres)						Study Area (acres)	Area[1] (%)
	Depression	Flat	Slope	Riverine	River Channel	Total		
Evergreen Forested Wetlands	0	119.4	56.9	30.5	0	206.8	17,537.9	1%
Deciduous Forested Wetlands	0	0.4	0.6	0.0	0	0.9	235.0	<1%
Mixed Forested Wetlands	0	0	7.4	21.9	0	29.3	2,110.4	1%
Evergreen Scrub Shrub Wetlands	0	124.3	76.3	0.9	0	201.5	7,905.7	3%
Deciduous Scrub Shrub Wetlands	0.1	7.1	44.7	34.4	0	86.3	4,713.1	2%
Herbaceous Wetlands	3.1	0.5	8.4	4.5	0	16.5	413.8	4%
Ponds	0.0	0	0	0.8	0	0.8	35.8	2%
Rivers	0	0	0	0	11.0	11.0	317.0	3%
Intermittent Streams (miles)	NA	NA	NA	NA	NA	1.3	49.9	8%
Perennial Streams (miles)	NA	NA	NA	NA	NA	5.5	133.2	5%
Uplands	NA	NA	NA	NA	NA	47.5	7,222.6	1%
Area (acre)	3.3	251.7	194.3	92.9	11.0	600.7	40,491.2	1%
Wetland Area (acre, %)	1%	46%	35%	17%	2%	541.4	32,915.8	2%

Notes:

1 Proportion of drawdown area within mine site wetland study area by wetland category. Note that mosaic classes calculated as 100% wetlands overestimates the wetland area.

NA = Not Applicable
0 = None
0.0 = < 0.1

Source: Analysis based on drawdown data by BGC (2015b) and wetland data by 3PPI et al.2014.

Lowering the subsurface water table within permafrost-based wetlands may have little effect on surface moisture, especially in flat HGM classes where moisture is primarily received as precipitation; unless there is also an associated collapse in the permafrost from thermal degradation. Collapse scars in bogs create moister conditions that result in losses of evergreen and deciduous trees and gains in sedges with increased moss productivity in newly formed collapse scars (Churchill 2011).

Table 3.11-19: Alternative 2 Mine Site Potential Dewatering Preliminary Calculation of Wetland Indirect Impacts on Preliminary Wetland Hydrologic Function Ratings

Wetland Category / FCI Model Rating[1]	Low (acres)	Moderate (acres)	High (acres)	Drawdown Area (acres)
Modification of Groundwater Discharge				
Evergreen Forested Wetlands	3.2	173.0	19.8	195.9
Deciduous Forested Wetlands	0	0.9	0	0.9
Mixed Forested Wetlands	0	25.1	0	25.1
Evergreen Scrub Shrub Wetlands	0	190.4	6.1	196.5
Deciduous Scrub Shrub Wetlands	0	44.9	39.5	84.4
Herbaceous Wetlands	0.1	13.5	3.0	16.5
Ponds	0	0.7	0.2	0.8
Wetland Area	3.3	448.5	68.5	520.3
Modification of Stream Flow				
Evergreen Forested Wetlands	70.9	10.1	14.1	95.1
Deciduous Forested Wetlands	0.4	0	0	0.4
Mixed Forested Wetlands	20.1	1.0	0	21.1
Evergreen Scrub Shrub Wetlands	72.1	0.3	0.4	72.8
Deciduous Scrub Shrub Wetlands	13.6	22.1	27.0	62.7
Herbaceous Wetlands	3.6	7.3	2.9	13.7
Ponds	0.0	0.7	0.1	0.8
Wetland Area	180.6	41.5	44.4	266.5

Notes:

1 Functional Capacity Index (FCI) rating (Low > 0 and < 0.33; Moderate (Mod) ≥ 0.33 and < 0.66; High ≥ 0.66). Note that mosaic classes calculated as 100% wetlands overestimates the wetland area.

NA = Not Applicable
0 = None
0.0 = < 0.1

Source: BGC 2015n, 3PPI 2014b

Closure, Reclamation, and Monitoring

During reclamation, flat to gently sloping wetland areas would generally be reclaimed by removal of fill and grading to recreate original contours and hydrologic regimes. Depression areas would be reclaimed to emergent wetlands where the hydrology permits. Culverts and fill would be removed from channels and active floodplains. Steam embankments would be revegetated with native riparian plants such as willows and erosion-controlling grasses such as *Calamagrostis canadensis*. Material sites constructed in valley bottoms, lowland sites, or in black spruce permafrost wetlands could be reclaimed to create new ponds with emergent wetlands where sufficient water quality and hydrology are available. Final contouring around created ponds could focus on providing water's edge habitat and a complex interspersion between wetland and upland vegetation. Moderate to steeply sloping wetland or upland mosaics with wetland inclusions would be less feasible to restore to wetlands because of the marginal hydrology and some fills may not be removed in these areas. Marginal wetland hydrology would be expected in areas where the permafrost has melted from clearing and excavation, and in areas where excavations and road cuts through colluvium and rock have reduced overland sheet flow.

Closure and post-closure project-related ground disturbing reclamation effects on wetlands would be similar to construction-related effects, although on a reduced scale. Disturbance to surrounding wetlands could occur during the removal of existing facilities, grading to recreate surface contours, and general ground disturbance that may result in sediment release, soil erosion, and spread of invasive species. Sedimentation would likely be of greater consequence in alpine herbaceous wetlands than in lowland wetlands and would result in decreased shoot density and species diversity (van der Valk et al. 1983).

Invasive species can be introduced or spread by contaminated construction equipment or in contaminated seed mixes or mulch. Invasive species that can affect wetlands by displacing native plants include, for example, orange hawkweed (*Hieracium aurantiacum*), reed canarygrass (*Phalaris arundinacea*), purple loosestrife (*Lythrum salicaria*), and elodea (*Elodea nuttallii*, *E. canadensis,* and hybrids; Shephard et al. 2007; Conn et al. 2008; Morgan and Sytsma 2009). None of these aquatic and wetland invasive species have been documented anywhere in the EIS Analysis Area (Moody 2015). Invasive species are discussed in more detail in Section 3.10 (Vegetation) and Section 3.13 (Fish and Aquatic).

Interior boreal forest wetland successional processes, generally initiated by natural disturbances such as wildland fires, gradually reestablish typical vegetation and permafrost and eventually hydrologic characteristics. When construction disturbs interior wetlands, successional processes may be prolonged or may not occur (ADEC 1999). Construction disturbances differ from natural disturbance in that the organic mat and organic soil horizons are often removed completely, which facilitates melting of permafrost, drains supra-permafrost groundwater, removes seedbeds, and reduces surface and subsurface water storage capacity (ADEC 1999). Timing and extent of recovery likely depend on the intensity, extent, and duration of the disturbance; and the time required for wetlands to return to pre-disturbance depth of permafrost, soil moisture, and original vegetation cover has not been well documented in interior Alaska (ADEC 1999).

Most reclamation actions focus on establishing plant cover to provide insulation, stop erosion processes, and improve site appearance (Forbes and Jefferies 1999). Active post-construction and closure wetland revegetation would include seeding of prepared seedbeds with native grass varieties including: 'Egan' American sloughgrass (*Beckmannia syzigachne*), 'Norcoast' Bering hairgrass (*Deschampsia beringensis*), 'Arctared' red fescue (*Festuca rubra*), and 'Alyeska' polargrass (*Arctagrostis latifolia*) (Wright 2008; Czapla and Wright 2012; SRK 2012f). Some native grasses such as red fescue, when heavily seeded and fertilized, may exclude reestablishment of native forbs and shrubs (Czapla and Wright 2012). Addition of fertilizer favors graminoids and can substantially alter abundance and plant community composition (Forbes and Jefferies 1999). Development of self-sustaining wetland plant communities on previously disturbed Alaska wetlands may occur within 10 to 30 years, but may be slowed in gravel or sandy soils and by years with failed seedling establishment or seed production (Forbes and Jefferies 1999). Effects of treatments and seed mixtures are likely to only be evident after 20 to 25 years because of the slow rates of vegetation development in Alaska (McKendrick 1997).

Donlin Gold's previous experience with revegetation associated with exploration activities at the mine site has found that careful planning and management; minimizing disturbance; segregating and protecting materials to be used during reclamation; using the appropriate seed mixture and seeding rates; continuing monitoring for erosion and revegetation success; and limiting or avoiding the use of fertilizer especially in hydric soils are important for successful revegetation. The grass mix that has been used successfully for revegetation in hydric soils seeded at a rate of 15 pounds per acre included: 'Egan' American sloughgrass (45 percent), 'Norcoast' Bering hairgrass (40 percent), 'Arctared' red fescue (10 percent), and 'Alyeska' polargrass (5 percent).

Restoration of wetland conditions would be complicated in areas where permafrost has degraded because insulating surface vegetation and vegetative mats have been removed, or where clay layers that prevented surface water percolation have been breached or removed. Both conditions would alter surface hydrology causing previous wetland areas to drain and dry. Successful restoration of native wetland vegetation cover and function would depend upon many factors; the most basic and difficult of which may be successful restoration of site hydrology (Ford and Bedford 1987; Post 1996; Graph 2009). Restored wetlands are likely to differ in type and functional capacity from the original wetlands for decades to centuries.

During closure, the pit would be filling with water and the TSF area would be reclaimed, and surface waters available to wetlands would continue to be affected by diversion and storage. Water from the pit would be treated and discharged to Crooked Creek after the pit level reaches 33 feet below the low point of the pit crest. A spillway would be constructed between the TSF pond and Crevice Creek that would divert surface water to this drainage after it has been determined to be of suitable water quality for discharge. Surface water resources available to wetlands would continue to be altered in distribution and abundance with an estimated return to within 4 percent of Crooked Creek pre-development stream flows at the downstream end of the mine development (see Section 3.5, Surface Water Hydrology). These changes in surface water distribution and abundance would result in some wetlands potentially drying while others would be inundated or become wetter.

After the pit fills with water, a new equilibrium groundwater level would become established. Because the pit lake level would be below the elevation of Crooked Creek the section of the creek that runs along the pit lake would lose groundwater to the cone of depression created by the pit lake. This could result in long term wetland and stream flow effects. The drawdown analysis presented for operations represents the greatest levels for potential wetland dewatering and identifies those wetlands and functions that are likely to be affected. These same wetland areas are likely to be effected to a lesser extent by the long-term impacts to stream flow resulting from the new equilibrium groundwater surface. There is insufficient detail for the equilibrium groundwater level to quantify potential long-term impacts to wetlands.

Of the 6,967 acres of wetlands that would be directly affected by the mine footprint, approximately 325 acres would be affected by vegetation clearing and may be restorable to wetland conditions at or before mine closure (Table 3.11-20). Wetland areas affected by excavation or filling may not be restorable to wetland conditions (Table 3.11-20). Restoration of wetland hydrology in areas where permafrost has melted, especially areas subject to subsidence and draining in slope or riverine HGM classes, may be difficult or unsuccessful. Of the wetland areas that would be cleared of vegetation and may be restorable to wetland conditions, 59 percent are potentially supported by permafrost, based on modelled permafrost distribution (Figure 3.11-21, Table 3.11-21). Permafrost-based wetlands in the vegetation clearing areas are primarily (89 percent) flat HGM wetlands, 10 percent are slope, and 1 percent are riverine HGM classes (Figure 3.11-21, Table 3.11-21).

Table 3.11-20: Alternative 2 Mine Site Preliminary Calculation of Wetland Direct Impacts for Areas Identified as Cut or Fill and Vegetation Clearing Only

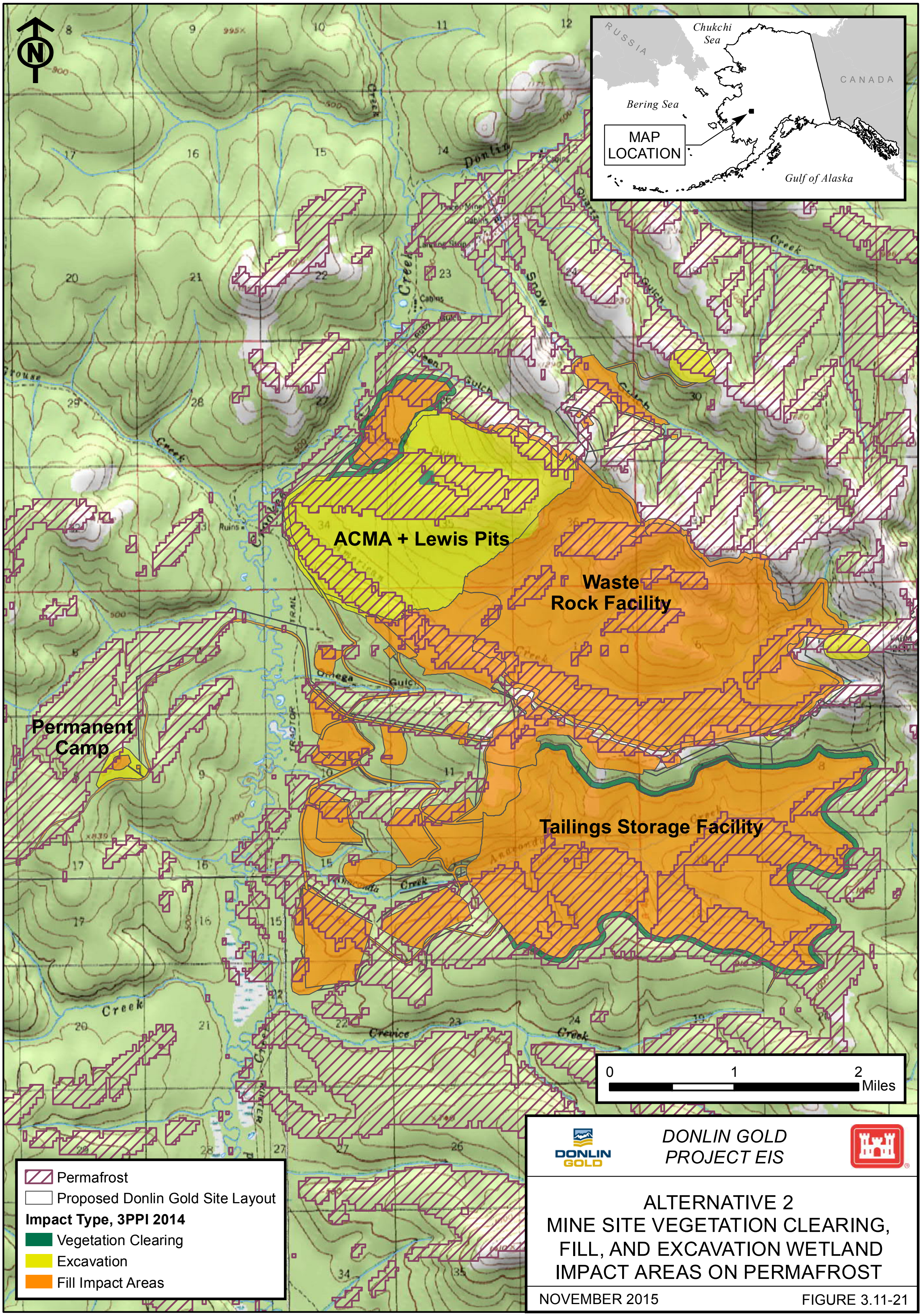
Wetland Category	Total Impact Area (acres)	Cut or Fill Impacts		Vegetation Clearing Impacts	
		Area (acres)	Area (%)	Area (acres)	Area (%)
Evergreen Forested Wetlands	4,402.9	4,163.6	95%	239.4	5%
Deciduous Forested Wetlands	1.2	1.1	91%	0.1	9%
Mixed Forested Wetlands	366.4	334.8	91%	31.5	9%
Evergreen Scrub Shrub Wetlands	1,639.2	1,600.8	98%	38.3	2%
Deciduous Scrub Shrub Wetlands	516.9	501.9	97%	15.0	3%
Herbaceous Wetlands	40.1	39.1	97%	1.0	3%
Ponds	1.1	1.0	96%	0.1	4%
Rivers	0.5	0.4	92%	0.1	8%
Uplands	2,043.0	2,023.1	99%	19.9	1%
Total Area	9,011.2	8,665.8	96%	345.4	4%
Wetland Area	6,966.7	6,641.3	95%	325.4	5%

Notes:

1 Proportion of impact area identified for reclamation by wetland category. Note that mosaic classes calculated as 100% wetlands overestimates the wetland area.

NA = Not Applicable
0 = None
0.0 = < 0.1

Source: 3PPI et al.2014.



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ALTERNATIVE 2
MINE SITE VEGETATION CLEARING, FILL, AND EXCAVATION WETLAND IMPACT AREAS ON PERMAFROST

NOVEMBER 2015

FIGURE 3.11-21

Table 3.11-21: Alternative 2 Mine Site Preliminary Calculation of Wetland Vegetation Clearing Impact Areas Located on Permafrost

Wetland Category	Permafrost – HGM Class (acres)					Study Area (acres)	Area[1] (%)
	Flat	Slope	Riverine	River Channel	Total		
Evergreen Forested Wetlands	132.1	5.7	0.5	0	138.2	17,537.9	0.8%
Deciduous Forested Wetlands	0	0.0	0	0	0.0	235.0	<0.0%
Mixed Forested Wetlands	0.0	10.2	0.0	0	10.3	2,110.4	0.5%
Evergreen Scrub Shrub Wetlands	31.1	1.8	0.0	0	33.0	7,905.7	0.4%
Deciduous Scrub Shrub Wetlands	8.0	1.8	0.2	0	9.9	4,713.1	0.2%
Herbaceous Wetlands	0.7	0.2	0.0	0	0.9	413.8	0.2%
Ponds	0	0	0	0	0	35.8	0%
Rivers	0	0	0	0.0	0.0	317.0	<0.0%
Uplands	NA	NA	NA	NA	8.1	7,222.6	0.1%
Area[1] (acre)	171.9	19.8	0.8	0.0	200.5	40,491.2	0.5%
Wetland Area (acre, %)	89%	10%	<1%	<1%	192.4	32,915.8	0.6%

Notes:

1 Proportion of vegetation clearing area located on permafrost by wetland category. Note that mosaic classes calculated as 100% wetlands overestimates the wetland area.

NA = Not Applicable 0 = None 0.0 = < 0.1

Source: analysis based on modeled permafrost distribution and wetland data 3PPI et al. 2014.

Avoidance, Minimization, and Compensatory Mitigation

Donlin Gold has incorporated procedures to be implemented during mine site construction, operations, and closure designed to avoid and minimize adverse impacts to wetlands; and has committed to provide compensation for unavoidable wetland impacts. Strategies used to avoid and minimize potential wetland impacts for the mine site and facilities as outlined in the preliminary Section 404 and Section 10 permit application (3PPI and Resource Data 2014) include:

- Site infrastructure and roads to avoid wetland areas whenever possible, cross drainages at right angles, and use bridges on larger drainages.
- Design the mine footprint to minimize the number of watersheds potentially disturbed.
- Select material sites to avoid wetlands where feasible.
- Route transmission lines in proximity to roads, where possible, to reduce wetland footprints and the number of drainages potentially disturbed.
- Use brush berms along the toe of fills, where feasible, to control erosion.

- Develop multiple use facilities to allow using the same location for more than one purpose over the life of the mine.

Adopted BMPs and closure standards that would minimize potential impacts on wetlands include (ARCADIS 2013a; 3PPI and Resource Data 2014):

- Design and implement BMPs during mine construction and operations to minimize direct and indirect impacts to wetlands.
- Design drainage systems to provide storm flow capacity consistent with pre-mining conditions that support post-mining land use and water quality objectives and minimize ongoing maintenance requirements.
- Recontour the land surface to support the overall drainage of the site, the long-term geotechnical stability, and post-mining land use blending with the existing landscape as feasible.
- Revegetate disturbed areas with self-sustaining vegetation cover that maintains slope stability, reduces potential erosion, and supports post-mining land use.
- Prevent introduction of invasive species to wetlands through detailed practices and BMPs specified in Sections 3.10, Vegetation, and 3.13, Fish and Aquatic.
- Train site construction managers in basic wetland identification and permit stipulations.
- Clearly delineate permitted disturbance boundaries prior to construction work.
- Use wetland mapping to guide placement of culverts to maintain natural drainage to the extent possible.
- Develop Erosion and Sediment Control Plan with sediment control measures.
- Develop Storm Water Pollution Prevention Plan.
- Develop a Facility Response Plan; Oil Discharge Prevention and Contingency Plan; and Spill Prevention, Control and Countermeasures Plan for oil; and an Emergency Response Plan for chemicals.
- Implement State of Alaska standards for mine closure.

During closure or at the conclusion of mine-related activities in a specific area, Donlin Gold would work to reestablish wetlands wherever practicable. Because all wetland impacts could not be avoided, compensatory mitigation may be required for unavoidable impacts to wetlands and waters after all practicable avoidance and minimization measures have been incorporated into the project. Compensatory mitigation may include: 1) restoration of previously existing wetlands or waters, 2) enhancing or improving functions of existing wetlands or waters, 3) creation of new wetlands or waters, or 4) preservation of existing wetlands or waters. Compensatory mitigation may be provided through permittee-responsible mitigation activities, or as payment for preserving existing wetlands through mitigation banks or in-lieu fees. As discussed in Section 3.11.1, Donlin Gold would develop a watershed-based CMP in coordination with federal, state, and local governments and landowners. Donlin Gold's conceptual CMP has identified potential compensatory mitigation mechanisms for unavoidable loss of wetlands (Table 3.11-22). Specific compensatory mitigation for the proposed Donlin Gold Project would be determined by the Corps during its review of the Section 404 and Section 10 permit applications. Mitigation is further discussed in Chapter 5, Impact Avoidance, Minimization, and Mitigation.

Table 3.11-22: Alternative 2 Mine Site Potential Compensatory Mitigation Mechanisms for Losses of Aquatic Resources

Mitigation Type	Status	Description	Potential Compensation Area
Mitigation Bank			
Kuskokwim River Mitigation Bank	POA-2014-028; In Review	Sponsored by Calista, the Kuskokwim River Umbrella Mitigation Bank, if approved, would cover the service area for the mine site, and could be used to purchase credits for the permanent and temporal impacts in waters of the U.S. within the Kuskokwim River region. The Donlin Gold Project is located within the Aniak subbasin (HUC 8-190301) where the Fuller Creek Mitigation Bank (10,880 acres) is proposed.	23,000 acres
In-Lieu Fee Program			
Alaska In-Lieu Fee Compensatory Mitigation Program	Inactive	Sponsored by The Conservation Fund, the in-lieu fee program was issued advance credits within the Interior Alaska Region.	Currently 0 acres
Permittee-Responsible Mitigation Plans			
PRM-001, Upper Crooked Creek Mine Site Restoration	Conceptual	Sponsored by Donlin Gold, the objective of this plan is to restore, rehabilitate, and enhance wetland areas disturbed by placer mining in the Upper Crooked Creek watershed. The focus would be to restore natural vegetation and function for the disturbed stream channels to return channels to their natural alluvial valley setting with natural dimensions, patterns, and profiles.	379 acres
PRM-002, Ad Hoc Pilot Recycling Plan	Conceptual	Sponsored by Donlin Gold, the objective of this plan is to provide a vehicle for governmental or nongovernmental organizations to act as contractors to provide compensatory mitigation through recycling and cleanup programs focused on restoration and enhancement of wetlands within the watershed.	24 acres
PRM-003, Non Native Plant Removal	Conceptual	Sponsored by Donlin Gold, the objectives of this plan are to develop and implement best management practices to eradicate existing invasive species in order to prevent establishment of additional non-native species and/or spread of existing population during proposed mitigation operations in the Crooked Creek watershed.	TBD

Table 3.11-22: Alternative 2 Mine Site Potential Compensatory Mitigation Mechanisms for Losses of Aquatic Resources

Mitigation Type	Status	Description	Potential Compensation Area
PRM-004, Ad Hoc Self-Nomination Using Village Outreach	Conceptual	Sponsored by Donlin Gold, the objective of this plan is to provide a vehicle for governmental or nongovernmental organizations to act as contractors to provide compensatory mitigation through identification of potential projects within their communities such as: use of interlocking porous mats to protect wetland and stream crossing; boat and barge landing improvements, improve fueling locations; improve washeterias and septic or sewage systems.	100 acres
PRM-005, Ad Hoc Crooked Creek Landfill and Village Sanitation Project Improvements	Conceptual	Sponsored by Donlin Gold, the objective of this plan is to assist local villages with management of sanitation to improve wetlands and water quality in the local area as well as the watershed.	20 acres
PRM-006, Wetland Creation on the Tailings Storage Facility at Abandonment	Conceptual	Sponsored by Donlin Gold, the objective of this plan is to replace the lost valley bottom and the sides of the Anaconda Valley that would be dammed and filled by the tailings storage facility with an elevated flat HGM wetland after mining and tailings deposition.	1,860 acres
PRM-009, Pit Lake Development	Conceptual	Sponsored by Donlin Gold, the open pit upon termination of mining would fill with water creating a lake that will be left as a landscape feature for use by wildlife.	1,007 acres
PRM-010, Getmuna Falls Obstruction Removal	Conceptual	Sponsored by Donlin Gold, the objective of this plan is to remove a natural barrier that include a series of low falls and cascades within an incised gorge to provide unrestricted access to about 2 miles of spawning and rearing habitat upstream from the barrier.	2 miles
PRM-011, Reconnect Backwater Sloughs Crooked Creek	Conceptual	Sponsored by Donlin Gold, the objectives of this plan are to increase the quantity of river channel habitat for spawning fish and create new fish spawning and rearing habitat.	TBD
PRM-012, ATV Trail Hardening Projects	Conceptual	Sponsored by Donlin Gold, the objectives of this plan are to restore wetlands and stream channels that have been disturbed by ATV trails.	TBD
PRM-013, Snow Gulch Creek Restoration	Conceptual	Sponsored by Donlin Gold, the objectives of this plan are to restore the placer mined section of Snow Gulch to increase the quantity of river channel spawning habitat, restore the natural fluvial geomorphology, and create new fish habitat.	TBD

Source: Michael Baker International 2015.

Summary of Impacts for Mine Site

Anticipated Alternative 2 mine site direct effects on wetlands would be medium to high in intensity with an observable 21 percent reduction in wetland abundance (Table 3.11-14) and impacts to between 10 and 37 percent of high functioning wetlands (Table 3.11-15) within the mine site wetland study area during construction and operations; siting and design features have been used to avoid and minimize wetland impacts. Effects would be long-term to permanent in duration throughout construction and the operational life of the mine; during closure or at the conclusion of mine-related activities in a specific area, wetlands would be reestablished wherever practicable. The geographic extent of direct and indirect effects would be local (affecting several sub-drainages within the Crooked Creek drainage); mine design focused on minimizing the number of drainages that would be disturbed. Most impacts (87 percent) would be to black spruce dominated wetlands (evergreen forested and scrub shrub wetlands) that are common throughout the region (Table 3.11-23). There would be a few impacts to wetlands that support anadromous fish streams and regionally scarce wetland categories including herbaceous wetlands and open water ponds (Table 3.11-23). The overall impact of the construction, operations, closure, and reclamation of the mine site for Alternative 2 on wetlands would be considered moderate.

Table 3.11-23: Alternative 2 Mine Site Summary of Preliminary Calculation of Wetland Direct and Indirect Impacts

Wetland Category	Construction, and Operations and Maintenance Direct Impact Area[1] (acre)	Potential Dust Indirect Impact Area[2] (acre)	Potential Dewatering Indirect Impact Area[3] (acre)	Vegetation Clearing Area with Permafrost[4] (acre)
Evergreen Forested Wetlands	4,402.9	1,026.6	206.8	138.2
Deciduous Forested Wetlands	1.2	0.8	0.9	0.0
Mixed Forested Wetlands	366.4	90.8	29.3	10.3
Evergreen Scrub Shrub Wetlands	1,639.2	684.5	201.5	33.0
Deciduous Scrub Shrub Wetlands	516.9	142.5	86.3	9.9
Herbaceous Wetlands	40.1	8.6	16.5	0.9
Ponds	1.1	0.7	0.8	0
Rivers	0.5	3.0	11.0	0.0
Intermittent Streams (miles)	13.4	1.3	1.3	NE
Perennial Streams (miles)	28.7	1.9	5.5	NE

Table 3.11-23: Alternative 2 Mine Site Summary of Preliminary Calculation of Wetland Direct and Indirect Impacts

Wetland Category	Construction, and Operations and Maintenance Direct Impact Area[1] (acre)	Potential Dust Indirect Impact Area[2] (acre)	Potential Dewatering Indirect Impact Area[3] (acre)	Vegetation Clearing Area with Permafrost[4] (acre)
Wetland Area	6,966.7	1,953.9	541.4	192.4

Notes:

NE = Not Evaluated

1 Mine site footprint impact areas – see Table 3.11-14 for breakdown by HGM class.

2 Mine site potential indirect dust impact areas – see Table 3.11-16 for breakdown by HGM class

3 Wetlands potentially affected by reduced groundwater within modeled maximum drawdown areas – see Table 3.11-18 for breakdown by HGM class

4 Mine site footprint impact areas identified as "vegetation clearing" located on modeled permafrost distribution – see Table 3.11-21 for breakdown by HGM class. Cleared wetlands supported by permafrost may not be restorable if the permafrost has been degraded.

3.11.4.2.2 TRANSPORTATION FACILITIES – CONSTRUCTION; OPERATIONS AND MAINTENANCE; AND CLOSURE, RECLAMATION, AND MONITORING

Angyaruaq (Jungjuk) Port, Mine Access Road, and Airstrip

Construction of the Angyaruaq (Jungjuk) Port, mine access road, and the mine airstrip and access road would disturb 412 acres of primarily flat HGM class evergreen forested and scrub shrub and deciduous scrub shrub wetlands (Table 3.11-24, Figure 3.11-22). Some of these impacts would be permanent as it is likely that the road would remain to facilitate closure monitoring at the mine site. A total of 1.8 miles of streams would be affected by construction, including 1.4 miles of perennial streams and 0.4 miles of intermittent streams (Table 3.11-24; 3PPI et al. 2014).

Table 3.11-24: Alternative 2 Transportation Facility Preliminary Calculation of Wetland Direct Impacts from Construction, and Operations and Maintenance

Wetland Category	Impact Area – HGM Class (acres)						Study Area (acres)	Area[1] (%)
	Depression	Flat	Slope	Riverine	River Channel	Total		
Evergreen Forested Wetlands	0	227.0	5.0	3.3	0	235.3	19,663.3	1%
Deciduous Forested Wetlands	0	0	0.1	0.3	0	0.4	299.3	<1%
Mixed Forested Wetlands	0	1.8	6.0	7.2	0	15.0	3,416.4	<1%
Evergreen Scrub Shrub Wetlands	0	61.1	13.5	0.2	0	74.7	8,554.1	1%

Table 3.11-24: Alternative 2 Transportation Facility Preliminary Calculation of Wetland Direct Impacts from Construction, and Operations and Maintenance

Wetland Category	Impact Area – HGM Class (acres)						Study Area (acres)	Area[1] (%)
	Depression	Flat	Slope	Riverine	River Channel	Total		
Deciduous Scrub Shrub Wetlands	0	72.5	7.2	2.9	0	82.5	9,068.2	1%
Herbaceous Wetlands	0.1	0.6	1.4	1.8	0	3.9	3,855.8	<1%
Ponds	0	0	0	0	0	0	52.0	0%
Rivers	0	0	0	0	2.5	2.5	644.4	<1%
Intermittent Streams (miles)	NA	NA	NA	NA	NA	0.4	30.7	1%
Perennial Streams (miles)	NA	NA	NA	NA	NA	1.4	263.5	1%
Uplands	NA	NA	NA	NA	NA	393.8	8,992.9	4%
Area (acre)	0.1	363.0	33.2	15.6	2.5	808.1	54,546.4	1%
Wetland Area (%, acre)	<1%	88%	8%	4%	1%	411.8	44,857.1	1%

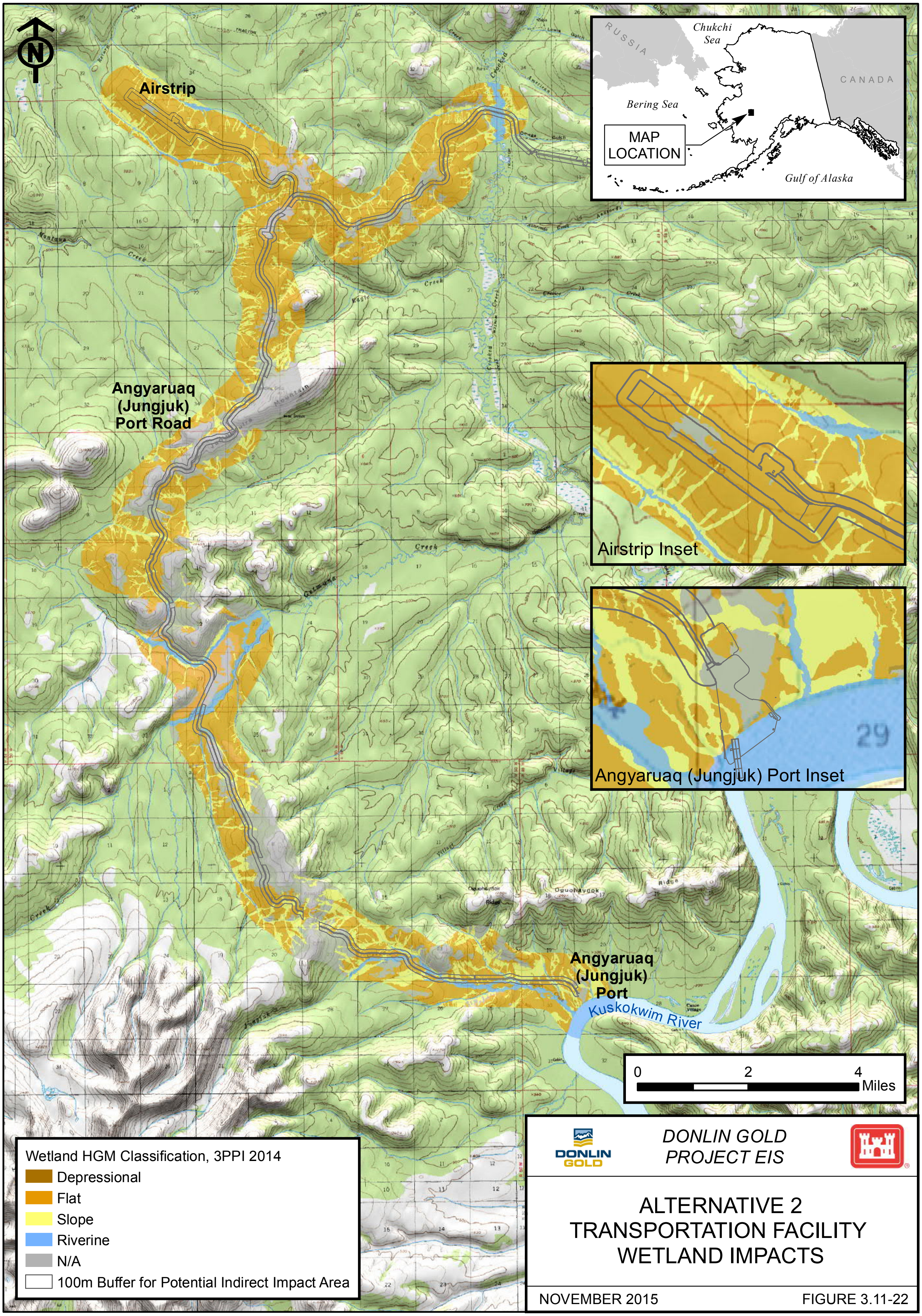
Notes:

1 Proportion of impact area within transportation wetland study area by wetland category. Mosaic classes calculated as 100% wetlands overestimates the wetland area.

NA = Not Applicable
0 = None
0.0 = < 0.1

Source: 3PPI et al. 2014.

Excavation, filling, and clearing of wetlands and waters for construction of the access road, port, and airstrip would alter or remove their capacity to provide hydrologic, biogeochemical, and biological functions. Construction-related disturbances could alter wetland modification of groundwater functions (recharge and discharge), would be expected to decrease storm and floodwater storage, and modify stream flow functions by decreasing the wetlands' potential to dissipate energy and reduce peak flows. Four percent or less of transportation wetland study area wetlands rated high for each of the four hydrologic functions would appear to be altered by construction of the access road, airstrip, and port facilities (Table 3.11-25, Appendix K, Tables K-10 and K-11; 3PPI 2014b). These altered hydrologic functions would extend to the streams connected to or downstream from the affected wetlands.



N
Airstrip
Angyaruaq (Jungjuk) Port Road
Angyaruaq (Jungjuk) Port
Kuskokwim River
Chukchi Sea
RUSSIA
CANADA
Bering Sea
MAP LOCATION
Gulf of Alaska
Airstrip Inset
29
Angyaruaq (Jungjuk) Port Inset
0
2
4
Miles
Wetland HGM Classification, 3PPI 2014
Depressional
Flat
Slope
Riverine
N/A
100m Buffer for Potential Indirect Impact Area
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TRANSPORTATION FACILITY
WETLAND IMPACTS
NOVEMBER 2015
FIGURE 3.11-22

Construction on or through wetlands would decrease or remove the wetlands' potential to improve water quality by preventing erosion and by settling sediments. Clearing with no ground disturbance was preliminarily modeled to reduce the modification of water quality biogeochemical function and to reduce the contribution to the abundance and diversity of wetland fauna; but was not expected to reduce the export of detritus or contribution to the abundance and diversity of wetland flora functions (3PPI 2014b). Wetlands affected by transportation facility construction would appear to include 1 to 2 percent of the high functioning wetlands for these biogeochemical and biological functions (Table 3.11-25). Wetland vegetation clearing that includes some ground disturbance and compaction was preliminarily modeled to reduce the modification of water quality function, the contribution to the abundance and diversity of wetland fauna, and all hydrologic functions (3PPI 2014b).

Table 3.11-25: Alternative 2 Transportation Facility Preliminary Calculation of Wetland Direct Impacts by Preliminary Wetland Function Ratings

Wetland Function Models	FCI Model Rating	Impact Area (acres)	Study Area[1] (acres)	Area[2] (%)	Impact Criteria (Magnitude)
Hydrologic Functions					
Modification of Groundwater Discharge	Low	10.4	418.5	2%	Low
	Mod	383.0	24,426.5	2%	Low
	High	18.4	566.8	3%	Low
Modification of Groundwater Recharge	Low	0	0	NA	NA
	Mod	352.3	17,189.2	2%	Low
	High	20.2	2,452.5	1%	Low
Storm and Floodwater Storage	Low	0.7	9.1	7%	Medium
	Mod	25.5	2,658.9	1%	Low
	High	385.7	22,754.8	2%	Low
Modification of Stream Flow	Low	83.8	16,454.1	1%	Low
	Mod	11.4	746.6	2%	Low
	High	19.0	448.7	4%	Low
Biogeochemical Functions					
Modification of Water Quality	Low	0.1	13.8	1%	Low
	Mod	1.5	1,101.9	<1%	Low
	High	410.3	24,307.1	2%	Low
Export of Detritus	Low	80.7	12,938.3	1%	Low
	Mod	4.2	2,014.9	<1%	Low
	High	32.0	2,763.3	1%	Low

Table 3.11-25: Alternative 2 Transportation Facility Preliminary Calculation of Wetland Direct Impacts by Preliminary Wetland Function Ratings

Wetland Function Models	FCI Model Rating	Impact Area (acres)	Study Area[1] (acres)	Area[2] (%)	Impact Criteria (Magnitude)
Biological Functions					
Abundance and Diversity of Wetland Flora	Low	0.5	18.2	3%	Low
	Mod	7.3	441.0	2%	Low
	High	404.1	24,970.0	2%	Low
Abundance and Diversity of Wetland Fauna	Low	0.1	16.6	1%	Low
	Mod	192.9	16,085.0	1%	Low
	High	218.8	9,327.6	2%	Low

Notes:

1 Totals reflect 44% of transportation wetland study area included in the wetland functional assessment (3PPI 2014b).

2 Proportion of impact area within transportation wetland study area rated for wetland functions by Functional Capacity Index (FCI) rating (Low > 0 and < 0.33; Moderate (Mod) ≥ 0.33 and < 0.66; High ≥ 0.66). Note that mosaic classes calculated as 100% wetlands overestimates the wetland area.

NA = Not Applicable
0 = None
0.0 = < 0.1

Source: 3PPI 2014b.

Dust generated by traffic on gravel roads and deposited on adjacent vegetation can change soil pH and bulk density, and raised road beds cause drifting and dust deposition on snow that results in early spring melt and deeper active layers next to the road in areas underlain by permafrost (Auerbach et al. 1997). Dust deposition would be heaviest within about 33 feet (10 meters) of the most heavily trafficked road (the mine access road), but may influence vegetation and soils within about 328 feet (100 meters) (Auerbach et al. 1997; Ford and Hasselbach 2001; Hasselbach et al. 2005). Alteration of wetlands near the airstrip and access road due to dust, snow removal and drifting may include altered nutrient distribution, changes in soil pH and bulk density, reduced vegetation biomass, changes in plant community composition and diversity, and potential long-term changes in permafrost active layer depth and site hydrology (Auerbach et al. 1997). Roads may also interrupt sheet flow, leading to upslope impoundment and downslope drying of wetlands. Indirect effects from the Jungjuk Road and airstrip could result in alteration or degradation of an estimated 1,734 acres of wetlands (Table 3.11-26). Dust suppression using road watering, and proper culvert sizing and placement would reduce these indirect impacts on wetlands and wetland functions.

The road would cross an estimated 6.5 miles of permafrost-supported wetlands including: the Crooked Creek crossing and the ascent for about 2 miles; segments between Two Bull Creek Valley and Getmuna Creek; the lower slopes of Basalt Pass; and from the lower crossing of Jungjuk Creek to the dock location. Geotextile and moderate fill would be used for road segments over permafrost to prevent thermokarst and subsidence (RECON 2011a).

Table 3.11-26: Alternative 2 Mine Access Road and Airstrip Preliminary Calculation of Wetland Potential Indirect Impacts from Dust

Wetland Category	Indirect Impacts[1] – HGM Class (acres)						Study Area (acres)	Area[2] (%)
	Depression	Flat	Slope	Riverine	River Channel	Total		
Evergreen Forested Wetlands	0	894.8	52.9	42.2	0	989.9	19,663.3	5%
Deciduous Forested Wetlands	0	2.5	1.0	3.7	0	7.2	299.3	2%
Mixed Forested Wetlands	0	13.6	29.7	40.0	0	83.3	3,416.4	2%
Evergreen Scrub Shrub Wetlands	0	304.8	93.5	4.0	0	402.3	8,554.1	5%
Deciduous Scrub Shrub Wetlands	0	163.0	55.3	18.8	0	237.0	9,068.2	3%
Herbaceous Wetlands	0.7	0.0	5.4	7.9	0	14.0	3,855.8	<1%
Ponds	0.0	0	0	0.5	0	0.5	52.0	1%
Rivers	0	0	0	0	6.0	6.0	644.4	1%
Intermittent Streams (miles)	NA	NA	NA	NA	NA	0.8	30.7	3%
Perennial Streams (miles)	NA	NA	NA	NA	NA	8.0	263.5	3%
Uplands	NA	NA	NA	NA	NA	816.8	8,992.9	9%
Area (acre)	0.7	1,378.8	237.8	117.2	6.0	2,557.2	54,546.4	5%
Wetland Area (%, acre)	<1%	79%	14%	7%	<1%	1,733.9	44,857.1	4%

Notes:

1 Potential indirect impact area within 328 feet (100 meters) around mine access road, airstrip and airstrip access road from dust deposition. Material sites and road footprints were excluded. Material sites and road footprints were excluded.

2 Proportion of indirect impact area in the mine transportation wetland study area by wetland category. Note that mosaic classes calculated as 100% wetlands overestimates the wetland area.

NA = Not Applicable
0 = None
0.0 = < 0.1

Source: 3PPI et al. 2014.

Snow drifts and interruption of sheet flow could alter wetland modification of groundwater functions (recharge and discharge), and may decrease storm and floodwater storage and modification of stream flow functions by decreasing the wetlands' potential to dissipate energy and reduce peak flows. Between 7 and 14 percent of transportation wetland study area wetlands rated high for each of these hydrologic functions may be affected by changes in hydrology and snow distribution (Table 3.11-27; 3PPI 2014b). These altered hydrologic functions could extend to the streams connected to or downstream from the affected wetlands.

Changes in soils, pH and vegetation productivity could reduce the modification of water quality biogeochemical and export of detritus functions, which may then also reduce the wetlands contribution to the abundance and diversity of wetland flora and fauna. Wetlands potentially indirectly affected by interruption of sheet flow and deposition of dust would include 7 to 10 percent of the high functioning wetlands for each of these biogeochemical and biological functions (Table 3.11-27).

Table 3.11-27: Alternative 2 Transportation Facility Preliminary Calculation of Wetland Potential Indirect Impacts from Dust by Preliminary Wetland Function Ratings

Wetland Function Models	FCI Model Rating	Potential Impact Area (acres)	Study Area[1] (acres)	Area[2] (%)	Impact Criteria (Magnitude)
Hydrologic Functions					
Modification of Groundwater Discharge	Low	71.6	418.5	17%	Medium
	Mod	1,581.7	24,426.5	6%	Medium
	High	78.7	566.8	14%	Medium
Modification of Groundwater Recharge	Low	0	0	NA	NA
	Mod	1,319.1	17,189.2	8%	Medium
	High	169.3	2,452.5	7%	Medium
Storm and Floodwater Storage	Low	2.3	9.1	26%	High
	Mod	164.2	2,658.9	6%	Medium
	High	1,566.7	22,754.8	7%	Medium
Modification of Stream Flow	Low	376.2	16,454.1	2%	Low
	Mod	85.2	746.6	11%	Medium
	High	60.3	448.7	13%	Medium
Biogeochemical Functions					
Modification of Water Quality	Low	1.7	13.8	12%	Medium
	Mod	23.8	1,101.9	2%	Low
	High	1,707.8	24,307.1	7%	Medium
Export of Detritus	Low	327.9	12,938.3	3%	Low
	Mod	29.3	2,014.9	1%	Low
	High	195.1	2,763.3	7%	Medium

Table 3.11-27: Alternative 2 Transportation Facility Preliminary Calculation of Wetland Potential Indirect Impacts from Dust by Preliminary Wetland Function Ratings

Wetland Function Models	FCI Model Rating	Potential Impact Area (acres)	Study Area[1] (acres)	Area[2] (%)	Impact Criteria (Magnitude)
Biological Functions					
Abundance and Diversity of Wetland Flora	Low	3.4	18.2	19%	Medium
	Mod	35.5	441.0	8%	Medium
	High	1,695.4	24,970.0	7%	Medium
Abundance and Diversity of Wetland Fauna	Low	2.3	16.6	14%	Medium
	Mod	775.0	16,085.0	5%	Medium
	High	957.1	9,327.6	10%	Medium

Notes:

1 Totals reflect 44% of transportation wetland study area included in the wetland functional assessment (3PPI 2014b).
2 Proportion of potential indirect impact area within the transportation wetland study area rated for wetland functions by Functional Capacity Index (FCI) rating (Low > 0 and < 0.33; Moderate (Mod) ≥ 0.33 and < 0.66; High ≥ 0.66). Note that mosaic classes calculated as 100% wetlands overestimates the wetland area.

NA = Not Applicable
0 = None
0.0 = < 0.1

Source: 3PPI 2014b.

Barge Operations

No additional facilities would be constructed along the barge route through the Kuskokwim River study area between Bethel and Angyaruaq (Jungjuk) Port. Barge traffic supporting mine operations would produce wakes that may increase shoreline erosion, potentially degrading shoreline wetlands. Erosion may lead to loss or conversion of wetland types, while sediments deposited in lowland wetlands may result in decreased shoot density and species diversity (van der Valk et al. 1983).

An analysis of wave energy produced by a projected 173 barge trips (102 fuel and 71 cargo barge train trips) per year indicated that barges impart the greatest wave energy on the return trips when they are unloaded and travel at higher rates of speed (BGC 2007c). Seasonal wave energy generated by barge traffic increases in relation to seasonal river tractive energy from downstream to upstream with about 3.5 percent near Akiachak and Akiak to about 12.1 percent near Aniak (BGC 2007c). An estimated 58 fuel barge and 64 cargo barge train trips would be required per year to supply the mine in Alternative 2. Wake energies generated by fuel barge trains are 150 to 400 percent greater than cargo barge trains and vary with the section of river (BGC 2007c). Applying these seasonal increases in wave energy to measured wetland erosion rates indicates that the largest increase in wetland erosion rates would occur in the lower segments of the river, even though the highest proportional increase in wave energy would occur in the upper segments of the river (Table 3.11-28). An estimated increase of 0.01 to 0.21 acre per mile per year (acre/mile/year) of shoreline wetland erosion, upstream to downstream, could be attributable to the increase in wave energy from project-related barge traffic.

This estimate is conservative, as it does not distinguish wind-generated waves, other vessel and skiff generated waves, or thermoerosional niching (BGC 2007c). Because thermoerosional niching, the process of undercutting of frozen banks by concomitant thawing and erosion and the primary process for bank erosion on the lower Kuskokwim River, is associated with spring and summer flood stage flows, waves induced by wind or barges were not considered to substantially affect bank erosion rates (BGC 2007c).

Table 3.11-28: Wetland Erosion Rates from the 1988 to 2006 by River Segment with Alternative 2 Projected Barge-Related Increases

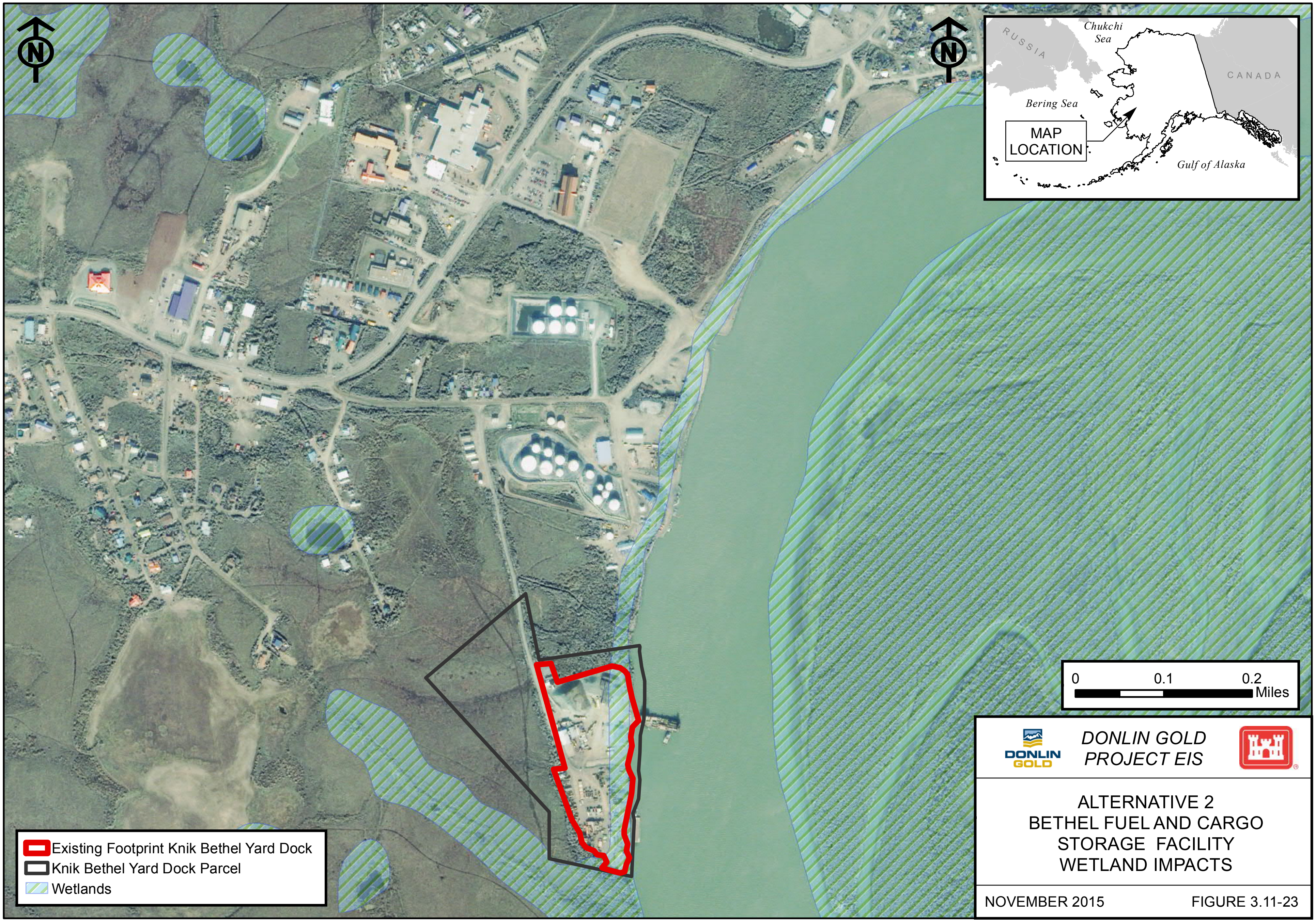
Wetland Type	Kuskokwim River Segments			
	Mouth to Bethel	Tuluksak	Kalskag	Aniak to Napaimute
Wetland Erosion Rates 1988 to 2006 (acres/mile)				
Estuarine and Marine Wetland	88.64	0.00	0.00	0.00
Freshwater Emergent Wetland	65.44	0.47	1.56	0.04
Freshwater Forested/Shrub Wetland	9.18	31.75	6.62	3.06
All Wetlands	163.26	32.22	8.18	3.09
Annual Erosion Rates (acres/mile/year)				
Estuarine and Marine Wetland	4.92	0.00	0.00	0.00
Freshwater Emergent Wetland	3.64	0.03	0.09	0.00
Freshwater Forested/Shrub Wetland	0.51	1.76	0.37	0.17
All Wetlands	9.07	1.79	0.45	0.17
Projected Annual Wetland Erosion Rate Increase (acres/mile/year)[1]				
Seasonal Wake Energy/River Tractive Energy	2.3%	2.9%	6.7%	7.5%
Estuarine and Marine Wetland	0.11	0	0	0
Freshwater Emergent Wetland	0.08	0.00	0.01	0.00
Freshwater Forested/Shrub Wetland	0.01	0.05	0.02	0.01
All Wetlands	0.21	0.05	0.03	0.01

Notes:

1 Seasonal erosion rate calculated from 18-year erosion measure divided by 18 years to give an annual erosion rate; increase in wave energy based on 58 fuel and 64 cargo barge trips per year applied as an annual increase in erosion rate.

Source: analysis based on data from ARCADIS 2007a, BGC 2007c, FWS 2014a.

Expansion at Dutch Harbor and Bethel may occur indirectly as a result of the mine because of project-related fuel and cargo storage requirements. Anticipated expansion at Dutch Harbor could result in 4 to 6 acres of impacts; diesel storage tanks would most likely be sited on uplands. Expansion at Bethel by Knik Construction, Inc. would result in direct loss of 2.9 acres of shoreline and riverine wetlands (Corps 2014a). A 16-acre area would also likely be required for additional diesel storage tanks and cargo storage (Figure 3.11-23); diesel storage tanks and cargo storage would most likely be sited on uplands. Some wetlands would be lost by



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ALTERNATIVE 2
BETHEL FUEL AND CARGO STORAGE FACILITY
WETLAND IMPACTS

NOVEMBER 2015

FIGURE 3.11-23

placement of fill during dock construction, and losses would likely persist beyond the life of the Donlin Gold mine. Additional fuel storage tanks and cargo facilities installed at Dutch Harbor and Bethel ports would not likely be sited on wetlands and would not likely be removed with closure of the mine.

Closure, Reclamation, and Monitoring

The Angyaruaq (Jungjuk) Port facilities would be partially reclaimed. A barge landing, the mine access road and the airstrip would remain to facilitate access to the site for post-closure monitoring. Reclamation of the port facility would include removal of all facilities, sheet piles, foundations, and drainage control structures. The port area would be regraded to approximate original contours or acceptable slopes, decompacted, covered with growth media if necessary, and seeded to promote vegetative growth. When the road is no longer required, road culverts would be removed, natural drainage areas would be restored or stabilized, erosion control structures would be installed, and road beds would be graded where necessary to provide drainage. Most flat to gently sloping wetlands would be reclaimed by removal of fill. Fill would not likely be removed in areas where marginal hydrology makes restoration of wetlands not feasible.

Avoidance, Minimization, and Compensatory Mitigation

Donlin Gold has incorporated facility siting and transportation facility construction, operations, and closure procedures to avoid and minimize adverse impacts to wetlands and has committed to provide compensation for unavoidable wetland impacts. Guiding principles included:

- Site access routes, airstrips and other transportation facilities along ridge tops to avoid wetland areas whenever possible;
- Install geosynthetic liner over permafrost or wetland areas to minimize thawing or degradation that could lead to requirements of excessive amounts of fill to avoid shoulder sloughing;
- Cross drainages at right angles and use bridges to cross larger drainages;
- Design transportation facilities to minimize the number of watersheds potentially disturbed;
- Use silt fences and brush berms along toes of fills where feasible to reduce sediment runoff and control erosion;
- Stabilize road cuts and seed as necessary to reduce sediment runoff;
- Reclaim flat or gently sloping wetlands by removal of fill at Project closure where feasible;
- Reclaim valley bottom and lowland material sites to create new wetland areas with ponds and emergent vegetation or black spruce wetlands; and
- Reclaim sections of the roads that would not be required to support long-term monitoring.

Donlin Gold would continue to work with the Corps to identify opportunities to avoid and minimize impacts to wetlands. Donlin Gold's conceptual CMP has identified potential compensatory mitigation mechanisms for unavoidable loss of wetlands (Table 3.11-29). Mitigation is further discussed in Chapter 5, Impact Avoidance, Minimization, and Mitigation.

Table 3.11-29: Alternative 2 Transportation Facility Potential Compensatory Mitigation Mechanisms for Losses of Aquatic Resources

Mitigation Type	Status	Description	Potential Compensation Area
Mitigation Bank			
Kuskokwim River Mitigation Bank	POA-2014-028; In Review	Sponsored by Calista, the Kuskokwim River Umbrella Mitigation Bank, if approved, would cover the service area for the mine site, and could be used to purchase credits for the permanent and temporal impacts in waters of the U.S. within the Kuskokwim River region. The Donlin Gold Project is located within the Aniak subbasin (HUC 8-190301) where the Fuller Creek Mitigation Bank (10,880 acres) is proposed.	23,000 acres
In-Lieu Fee Program			
Alaska In-Lieu Fee Compensatory Mitigation Program	Inactive	Sponsored by The Conservation Fund, the in-lieu fee program was issued advance credits within the Interior Alaska Region.	Currently 0 acres
Permittee-Responsible Mitigation Plans			
PRM-008, Material Site Restoration	Conceptual	Sponsored by Donlin Gold, the objective of this plan is create fish over-wintering and rearing habitat by connecting eight constructed material sites in the South Fork of Getmuna Creek.	115 acres

Source: Michael Baker International 2015.

Dust control would likely be necessary during about 6 months of the year and would be completed using large water trucks. During winter, road graders may be used to blade snow over the road surface to minimize dust. Areas where dust control would apply include primarily unpaved roads.

Summary of Impacts for Transportation Facilities

Anticipated Alternative 2 transportation facility direct effects on wetlands would be low in intensity with a 1 percent reduction in wetland abundance from direct construction and operations impacts (Table 3.11-24); and direct impacts to 1 to 4 percent, or potential indirect impacts to 7 to 14 percent of high functioning wetlands within the eight evaluated functions respectively (Table 3.11-25 and Table 3.11-27) within the transportation wetland study area. Some direct effects would be permanent in duration because the mine access road and airstrip would not be reclaimed. The geographic extent of transportation effects on wetlands would primarily be local (affecting wetlands in the vicinity of the mine access road, port, and airstrip within the Crooked Creek watershed). Most facility-related impacts (75 percent) would be to black spruce dominated wetlands (evergreen forested and scrub shrub wetlands) that are common throughout the region; although there would be some impacts to riverine wetlands that support anadromous fish streams and to regionally scarce herbaceous wetlands and open water ponds (Table 3.11-30). The overall impact of the construction and operations of transportation facilities and indirect effects from port expansions would be considered minor. Projected potential increases in wetland erosion rates resulting from barge wake energy represent an increase of 2 to 8 percent of river tractive energy along Kuskokwim River shorelines. Projected erosion rates, based on the assumed relationship between river tractive energy and shoreline erosion rates, are conservative and would be considered low in intensity should they occur. Barge activities would be medium-term in duration (during operational life of the mine) with resulting potential increases in wetland erosion returning to pre-activity function with closure of the mine. Barge activities on the Kuskokwim River would be regional in extent and could affect wetlands that are important for supporting anadromous fish streams and subsistence resources; the overall potential effects on wetlands would be considered low.

Table 3.11-30: Alternative 2 Transportation Facility Summary of Preliminary Calculation of Wetland Direct and Indirect Impacts

Wetland Category	Construction, and Operations and Maintenance Direct Impact Area[1] (acre)	Potential Indirect Dust Impact Area[2] (acre)
Evergreen Forested Wetlands	235.3	989.9
Deciduous Forested Wetlands	0.4	7.2
Mixed Forested Wetlands	15.0	83.3
Evergreen Scrub Shrub Wetlands	74.7	402.3
Deciduous Scrub Shrub Wetlands	82.5	237.0
Herbaceous Wetlands	3.9	14.0
Ponds	0	0.5
Rivers	2.5	6.0

Table 3.11-30: Alternative 2 Transportation Facility Summary of Preliminary Calculation of Wetland Direct and Indirect Impacts

Wetland Category	Construction, and Operations and Maintenance Direct Impact Area[1] (acre)	Potential Indirect Dust Impact Area[2] (acre)
Intermittent Streams (miles)	0.4	0.8
Perennial Streams (miles)	1.4	8.0
Wetland Area	411.8	1,749

Notes:

1 Transportation footprint impact areas – see Table 3.11-25 for breakdown by HGM class.

2 Potential indirect transportation indirect impact area from dust based on 328-foot (100-meter) buffer around roads and airstrip – see Table 3.11-27 for breakdown by HGM class.

Source: 3PPI et al. 2014.

3.11.4.2.3 NATURAL GAS PIPELINE – CONSTRUCTION; OPERATIONS AND MAINTENANCE; AND CLOSURE, RECLAMATION, AND MONITORING

Much of the pipeline construction through wetlands, about 87 percent by area, would occur during winter with reduced disturbance to wetlands and wetland soils. Donlin Gold proposes to use three methods for pipeline construction across wetlands:

- Ice or snow pads would be used to support equipment during winter construction through wetlands on permafrost soils;
- Frost-packing would be used to support equipment during winter construction through wetlands on non-permafrost soils, with additional support from timber corduroy or mats in wetlands with organic mat thickness of 3 or more feet; or
- Temporary work pads made from imported fill and / or trench soil or timber mats would be used to support equipment during summer construction through wetlands on non-permafrost soils.

Geotextile or mats would be used to separate fill and spoils from vegetation during summer construction through wetlands. If summer construction would be required for wetlands on permafrost, a granular fill work pad would be used to support equipment.

Construction of the pipeline would affect wetlands and their functions primarily during and immediately following construction activities before vegetation becomes reestablished, but permanent changes also are possible (FERC 2004).

Potential construction- and operations-related effects include:

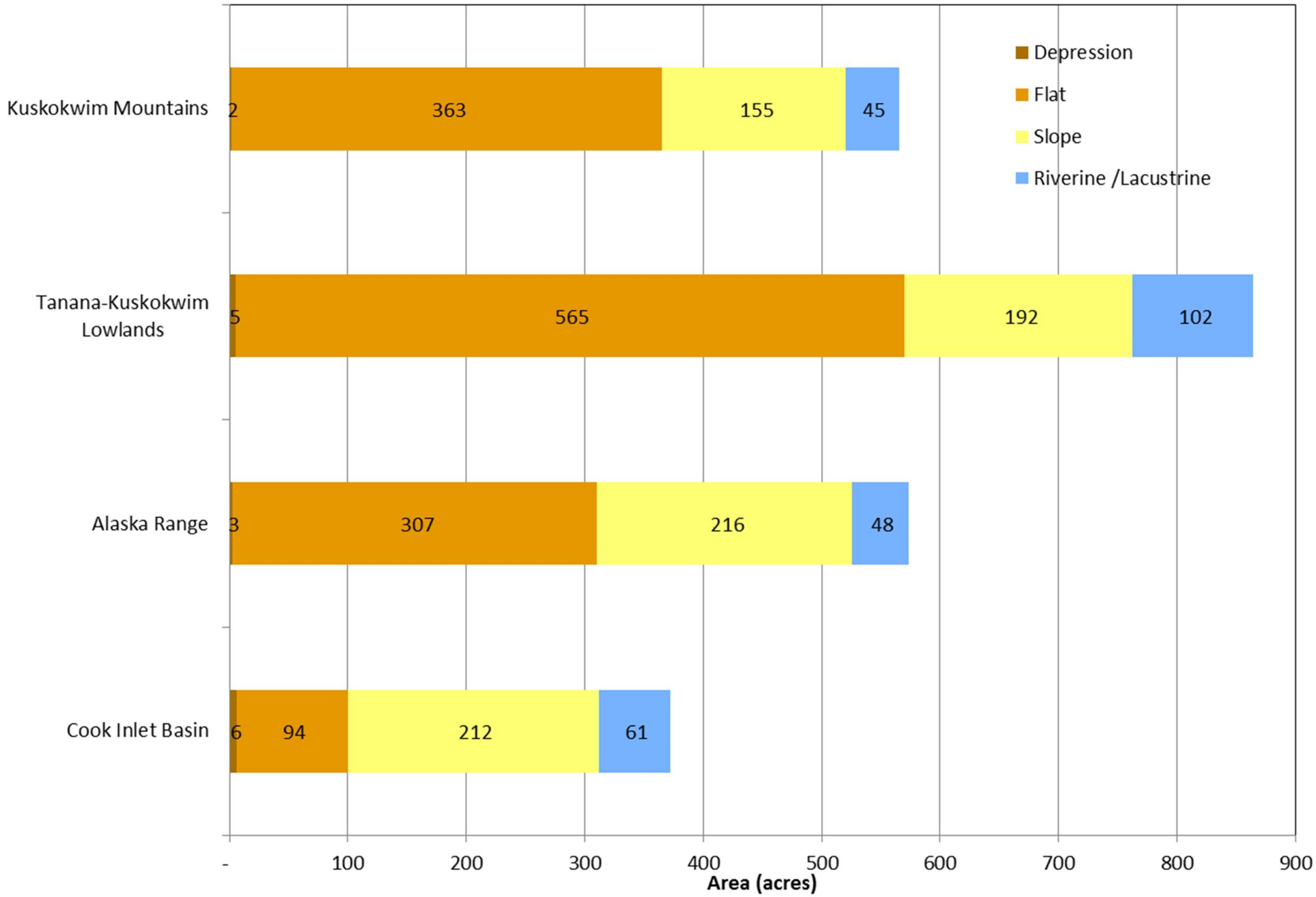
- Conversion of wetlands to uplands due to filling;
- Conversion of wetlands to uplands due to draining;
- Conversion of wetlands to open water due to disturbance of floating bogs;
- Modification of wetland productivity due to modification of surface and subsurface flow patterns;

- Temporary and permanent modification of wetland vegetation community composition and structure from clearing and operational maintenance (clearing temporarily affects the wetland's capacity to buffer flood flows and/or control erosion);
- Wetland soil disturbance (mixing of topsoil with subsoil with altered biological activity and chemical conditions that could affect reestablishment and natural recruitment of native wetland vegetation);
- Compaction and rutting of wetland soils from movement of heavy machinery and transport of pipe sections, altering natural hydrologic patterns, inhibiting seed germination, or increasing siltation;
- Temporary increase in turbidity and changes in wetland hydrology and water quality;
- Permanent alteration in water-holding capacity due to alteration or breaching of water-retaining substrates (volcanic ash or loess deposited clay layers) or degradation of permafrost;
- Alteration in vegetation productivity and life stage timing due to altered soil temperatures associated with heat or cold exchange from the pipeline; and
- Alteration in freeze-thaw timing due to increased water temperatures associated with heat or cold exchange from the pipeline.

Pipeline Construction

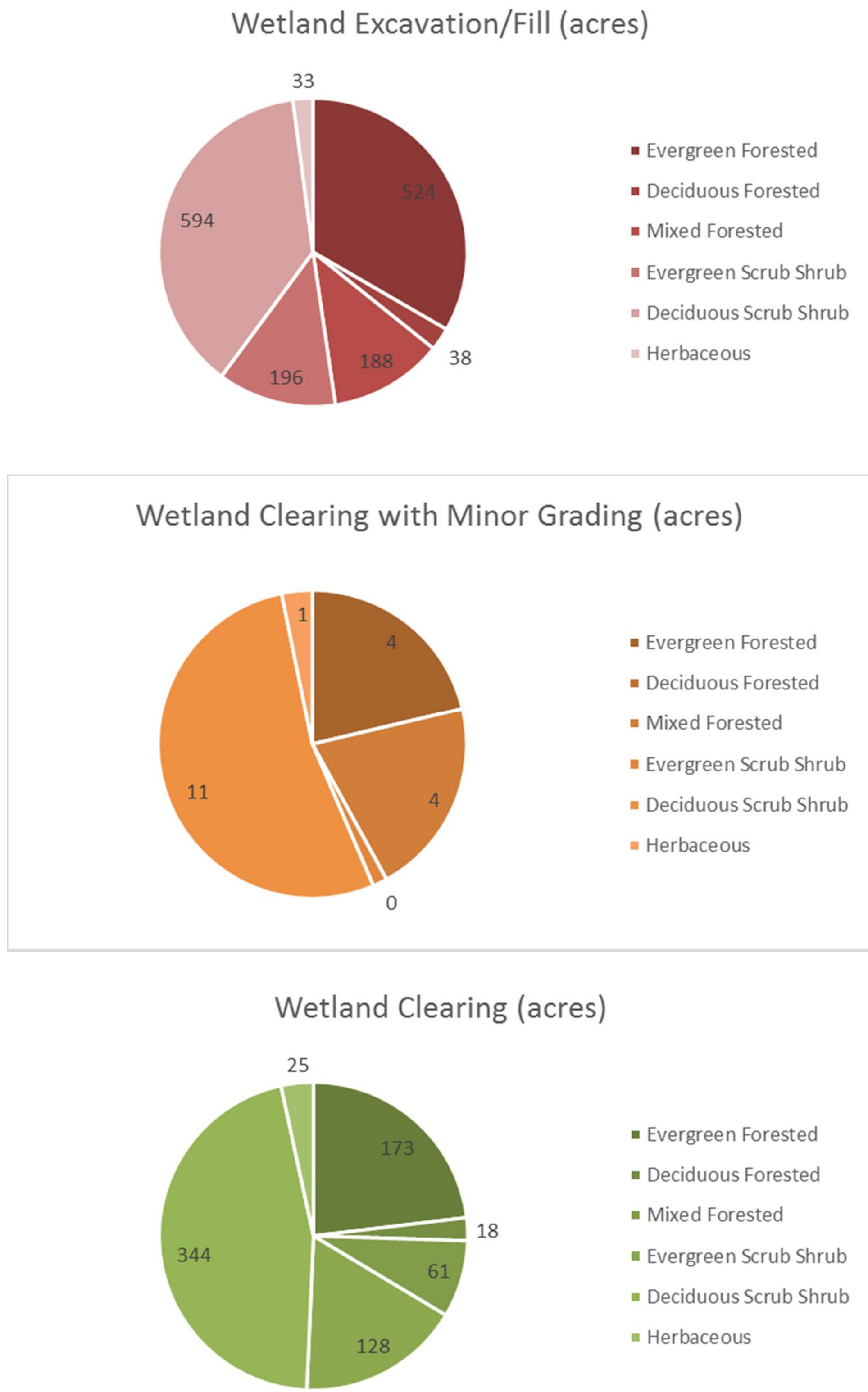
The acreage of herbaceous wetlands disturbed during pipeline construction would be small (59 acres), forested wetlands would be moderate (1,009 acres), as would the acreage of scrub shrub wetlands (1,272 acres, Table 3.11-31). The preponderance of evergreen forested and scrub shrub wetlands affected during pipeline construction reflects the ubiquity of black spruce dominated wetlands throughout the EIS Analysis Area (Table 3.11-31). Pipeline construction would affect a total of 21 miles of streams of which 63 percent (13 miles) are perennial streams and 37 percent (8 miles) are intermittent streams (Table 3.11-31, 3PPI et al. 2014). The proportion of flat HGM wetlands that would be affected by construction increases as the pipeline runs from MP 0 in the Cook Inlet Basin ecoregion through the Tanana-Kuskokwim Lowlands ecoregion (Figure 3.11-24). Slope and riverine wetlands follow an opposite trend with decreasing proportions from the Cook Inlet Basin to the Tanana-Kuskokwim Lowlands (Figure 3.11-24).

Wetlands disturbed during construction would be reclaimed shortly after installation of the pipeline. The type of disturbances include excavation and/or filling, vegetation clearing with minor grading, or vegetation clearing with no ground disturbance (Figure 3.11-25). Following reclamation and revegetation, few long-term effects on emergent wetland vegetation would be expected. Removal of trees and shrubs from wetlands may result in long-term to permanent conversion of forested and scrub shrub wetlands to herbaceous wetlands. Wetland vegetation communities would eventually transition back into a community functionally similar to the wetland prior to construction if pre-construction conditions such as elevation, grade, and soil structure are successfully restored (FERC 2004). Tree species that typically dominate forested wetlands in the EIS Analysis Area (black spruce, balsam poplar) have regeneration periods of 30 to 100 years or longer (ADEC 1999). Herbaceous wetland vegetation would regenerate more



Source: 3PPI et al. 2014.

Figure 3.11-24: Alternative 2 Pipeline Construction Wetland Impacts for Hydrogeomorphic Classes by Ecoregion



Source: 3PPI et al. 2014.

Figure 3.11-25: Alternative 2 Pipeline Construction Wetland Impacts by Disturbance Type

quickly (typically within 3 to 5 years) than shrub or forest communities (typically within 5 to 100 years). Although return to wetland status in areas maintained by permafrost may not return until permafrost aggrades to pre-disturbance levels (typically within 30 to 100 years or more, ADEC 1999).

Over one-quarter of the deciduous scrub shrub wetlands impacted by pipeline construction are identified as bog or fen habitats (Table 3.11-31). Pipeline construction through certain bogs and fens react similarly when a pipeline installation cuts through these wetlands during either winter or summer construction. The backfilled portion of the trench becomes an open water area. There may be no practicable effective mitigation measure to avoid this conversion. Beside avoidance through routing other potential mitigation measures could include avoidance of any surface vegetation impacts by using either horizontal boring or horizontal directional drilling (HDD) techniques. However, the abundance of bogs in central Alaska and the typical crossing lengths for these areas generally prohibit using simple HDD installations. Effective restoration of floating mat bog and fen areas may not be possible beyond compensation through mitigation banks.

Winter trenching trials were completed at the Washington Creek site north of Fairbanks along the Elliott Highway within open black spruce forest with tussock cottongrass (*Eriophorum vaginatum*), resin birch (*Betula glandulosa*), Labrador tea (*Ledum* spp.), mountain cranberry (*Vaccinium vitis-idaea*), and bog blueberry (*Vaccinium uliginosum*) (ABR and BPXA 2013). Trenches were backfilled using native soils with additional fill (gravel) used where necessary to mound the backfill 3.6 feet over the trench to limit permafrost thaw subsidence (ABR and BPXA 2013). The backfill was then fertilized and seeded with the introduced annual ryegrass (*Lolium multiflorum*) and native fireweed (*Chamerion angustifolium*) (ABR and BPXA 2013). The seeded grass was not found after 3 years post trenching (ABR & BPXA 2013). Erosion that required additional stabilization occurred where trenches intersected existing natural drainages but vegetation cover for cleared and trenched areas exceeded performance standards that included 30 percent or more live cover of vascular plants with 5 or more indigenous plants each with an average of 0.2 percent or more live cover within 3 years (ABR and BPXA 2013). After 10 years cottongrass tussocks damaged during construction appeared to have recovered and tree species had become established (ABR and BPXA 2013). Pipeline corridor effects on soils 8 years after summer installation in Wisconsin consistently showed compaction and hydraulic alteration with higher soil bulk density and lower soil moisture (Olson and Doherty 2012). Vegetation effects generally reflected lower diversity but effects were confounded by invasive wetland plants and post-construction remediation and vegetation management (Olson and Doherty 2012). Impacts of a 20-year-old pipeline through wetlands in a boreal forest in Wisconsin showed adjacent natural wetland areas were not altered in type; water sheet flow restriction had been reversed naturally; no nonnative plants invaded the natural area; 75 percent of the ROW area was a wetland; and the ROW increased overall vegetation and habitat diversity (Zimmerman et al. 1993).

Table 3.11-31: Alternative 2 Pipeline Construction Preliminary Calculation of Wetland Direct Impacts by Ecoregion

Wetland Category	Ecoregion (acres)				Impact Area (acres)	Study Area (acres)	Area[1] (%)
	Kuskokwim Mountains	Tanana-Kuskokwim Lowlands	Alaska Range	Cook Inlet Basin			
Evergreen Forested Wetlands	186.3	237.9	250.7	26.1	701.0	12,546.3	6%
Deciduous Forested Wetlands	7.7	13.2	1.0	33.7	55.6	1,004.5	6%
Mixed Forested Wetlands	44.1	61.8	6.8	139.7	252.3	3,937.2	6%
Evergreen Scrub Shrub Wetlands	133.2	139.0	33.8	17.4	323.5	6,953.9	5%
Deciduous Scrub Shrub Wetlands	184.7	375.1	255.9	132.5	948.2	23,134.0	4%
Fen (ESB – SB)	1.2	0	0.1	4.7	5.9	1,797.5	<1%
Bog (LSB)	31.0	165.9	10.7	19.3	226.8	6,467.3	4%
Herbaceous Wetlands	5.0	23.9	9.6	20.3	58.8	1,868.6	3%
Ponds	0.3	0.6	0.1	0.4	1.4	413.6	<1%
Lakes	0	0.2	0.2	0.0	0.4	151.9	<1%
Rivers	3.9	12.8	15.6	2.4	34.7	2,135.0	2%
Intermittent Streams (miles)	1.3	3.2	1.8	1.6	7.8	202.8	4%
Perennial Streams (miles)	3.3	3.8	1.6	4.6	13.3	306.8	4%
Uplands	1,376.8	230.3	1,109.1	1,037.1	3,753.4	57,864.5	6%
Area	1,942.0	1,094.8	1,682.8	1,409.7	6,129.3	110,010.6	6%
Wetland Area	561.0	850.8	557.9	369.8	2,339.5	49,444.6	5%

Notes:

1 Proportion of impact area in pipeline wetland study area by wetland category. Note that mosaic classes calculated as 100% wetlands overestimates the wetland area.

0 = None 0.0 = < 0.1
ESB – SB = Ericaceous Shrub Bog – String Bog
LSB = Low Shrub Bog

Source: 3PPI et al. 2014.

Excavation, filling, and clearing of wetlands and waters for construction of the buried pipeline, transmission line, construction camps, storage yards, workspaces and access roads could alter or remove the wetlands capacity to provide hydrologic, biogeochemical, and biological functions. Between 5 and 8 percent of pipeline study area wetlands rated high for the four hydrologic functions could be altered by trenching for pipeline wetland installation and associated activities (Table 3.11-32; Tables K-12 and K-13 in Appendix K; 3PPI 2014b). Trench plugs are measures typically installed during construction to prevent drainage of wetlands.

Altered hydrologic functions could extend effects to the streams connected to or downstream from the affected wetlands. Construction on or through wetlands would decrease or remove the wetlands' potential to improve water quality by preventing erosion and by settling sediments. Clearing with no ground disturbance was preliminarily modeled to reduce the modification of water quality biogeochemical function and to reduce the contribution to the abundance and diversity of wetland fauna; but would not be expected to reduce the export of detritus or contribution to the abundance and diversity of wetland flora functions (3PPI 2014b). Wetland vegetation clearing that includes some ground disturbance and compaction was preliminarily modeled to reduce the modification of water quality function, the contribution to the abundance and diversity of wetland fauna, and all hydrologic functions (3PPI 2014b). Wetlands potentially affected by pipeline installation would appear to include 5 to 7 percent of wetlands rated high for the four biogeochemical and biological functions (Table 3.11-32).

Post-construction restoration of some forested and scrub shrub wetlands may be possible; however, long-term effects are likely to remain. Restoration along the pipeline corridor in areas where wetland hydrology is supported by permafrost would be difficult, especially in slope and riverine HGM classes. An estimated 21 percent of wetlands within the pipeline construction right-of-way are supported by permafrost with about 13 percent on thaw stable permafrost and 8 percent on thaw unstable permafrost (Table 3.11-33). Most permafrost based wetlands are located within the Tanana-Kuskokwim Lowlands ecoregion and support deciduous scrub-shrub wetlands, although a high proportion of herbaceous wetlands are also permafrost based (Table 3.11-33). Thaw stable permafrost-based wetlands occurred in flat (84 percent) and slope (15 percent) wetlands, and thaw unstable permafrost-based wetlands occurred in flat (83 percent) and slope (16 percent) wetlands (3PPI et al. 2014).

Table 3.11-32: Alternative 2 Pipeline Construction Preliminary Calculation of Wetland Direct Impacts by Preliminary Wetland Function Ratings

Wetland Function Models	FCI Model Rating	Impact Area (acres)	Study Area[1] (acres)	Area[2] (%)	Impact Criteria (Magnitude)
Hydrologic Functions					
Modification of Groundwater Discharge	Low	92.5	811.1	11%	Medium
	Mod	2,012.8	41,233.1	5%	Medium
	High	230.6	3,260.6	7%	Medium
Modification of Groundwater Recharge	Low	0	8.1	0%	Low
	Mod	1,278.1	22,820.7	6%	Medium
	High	251.4	4,935.6	5%	Medium
Storm and Floodwater Storage	Low	0.1	10.0	1%	Low
	Mod	446.3	7,349.3	6%	Medium
	High	1,889.7	37,974.1	5%	Medium
Modification of Stream Flow	Low	343.0	20,752.9	2%	Low
	Mod	268.9	3,723.7	7%	Medium
	High	184.7	2,249.5	8%	Medium

Table 3.11-32: Alternative 2 Pipeline Construction Preliminary Calculation of Wetland Direct Impacts by Preliminary Wetland Function Ratings

Wetland Function Models	FCI Model Rating	Impact Area (acres)	Study Area[1] (acres)	Area[2] (%)	Impact Criteria (Magnitude)
Biogeochemical Functions					
Modification of Water Quality	Low	0.7	67.9	1%	Low
	Mod	24.2	621.7	4%	Low
	High	2,311.2	44,643.7	5%	Medium
Export of Detritus	Low	246.3	14,842.8	2%	Low
	Mod	83.4	4,114.4	2%	Low
	High	566.8	8,611.9	7%	Medium
Biological Functions					
Abundance and Diversity of Wetland Flora	Low	0.6	19.1	3%	Low
	Mod	60.8	965.8	6%	Medium
	High	2,275.3	44,360.8	5%	Medium
Abundance and Diversity of Wetland Fauna	Low	0.6	12.4	5%	Medium
	Mod	829.0	18,861.0	4%	Low
	High	1,507.1	26,472.3	6%	Medium

Notes:

1 Totals reflect 81% of pipeline wetland study area included in the wetland functional assessment (3PPI 2014b).

2 Proportion of potential impact area within pipeline wetland study area rated for wetland functions by Functional Capacity Index (FCI) rating (Low > 0 and < 0.33; Moderate (Mod) ≥ 0.33 and < 0.66; High ≥ 0.66). Note that mosaic classes calculated as 100% wetlands overestimates the wetland area.

NA = Not Applicable
0 = None
0.0 = < 0.1

Source: 3PPI 2014b.

Table 3.11-33: Alternative 2 Pipeline Construction Preliminary Calculation of Wetland Direct Impacts Located on Permafrost

Wetland Category	Ecoregion (acres)						Permafrost Area (acres)	Impact ROW Area[1] (acres)	Area[2] (%)
	Kuskokwim Mountains		Tanana-Kuskokwim Lowlands		Alaska Range				
	Stable	Unstable	Stable	Unstable	Stable	Unstable			
Evergreen Forested Wetlands	0.3	0	11.3	8.6	3.8	1.1	25.0	372.8	7%
Deciduous Forested Wetlands	1.7	0	0.4	0.0	0	0	2.2	10.9	20%
Mixed Forested Wetlands	0	0	0.5	0.0	0	0	0.5	51.2	1%
Evergreen Scrub Shrub Wetlands	1.6	0	8.9	13.9	4.0	0	28.4	232.2	12%
Deciduous Scrub Shrub Wetlands	1.9	0	87.0	70.8	46.6	5.3	211.6	662.1	32%
Bog (LSB)	0.8	0	37.5	38.3	2.2	0	78.8	182.3	43%
Herbaceous Wetlands	0.5	0	3.9	10.5	1.0	0.8	16.7	33.8	49%
Ponds	0	0	0	0	0	0	0.0	0.5	5%
Rivers	0.0	0	0	0	0.2	0.4	0.6	26.8	2%
Uplands	0	0	7.1	5.0	52.2	33.1	97.4	1,361.0	7%
Area (acre)	6.0	0	119.1	108.8	107.6	40.7	382.3	2,751.2	14%
Wetland Area (acre)	6.0	0	112.0	103.8	55.3	7.2	284.3	1,363.0	21%

Notes:

1 Impact area for 100 foot wide construction right-of-way (ROW) in Kuskokwim Mountains, Tanana-Kuskokwim Lowlands, and Alaska Range Ecoregions. No permafrost was mapped in the Cook Inlet Basin.
2 Proportion of Permafrost Area within ROW Impact Area by Wetland Category. Note that mosaic classes calculated as 100% wetlands overestimates the wetland area.

0 = None
0.0 = < 0.1
LSB = Low Shrub Bog

Source: 3PPI et al. 2014, see Section 3.2, Soils for description of Permafrost Analysis

Winter Access Routes

During construction of the pipeline winter access corridors would be developed in the Cook Inlet Basin to transport equipment and supplies over the 3-year construction period. Routes would be cleared of trees and shrubs with no ground disturbance. Winter access routes would be maintained by packing, watering, and grading the snow and ice surface. While portions of the routes are collocated with existing winter trails, some additional vegetation clearing would be required in areas where no trail exists and to widen existing trails from 10 or 15 feet to 30 feet. Preliminary estimates of potential wetland vegetation clearing and wetland distribution based on NWI and project wetland data are listed in Table 3.11-34, and shown in Figure 3.11-26.

Pipeline Operations

During pipeline operations, vegetation maintenance may remove shrub and sapling trees from an area over the pipeline to protect pipeline integrity and to facilitate visual observation of the pipeline ROW. Above-ground facilities would continue to impact wetlands. Materials sites would be reclaimed. Areas exhibiting erosion along the ROW identified during twice-yearly inspections would be remediated. The total acreage of wetlands potentially affected during operations (Table 3.11-35) would occur within areas that were initially disturbed during construction and would be reduced from construction-related impacts. The evergreen forested and scrub shrub wetlands affected during pipeline operations reflects the ubiquity of black spruce dominated wetlands throughout the pipeline Project Area (Table 3.11-35). Evergreen forested wetlands that would be affected are 77 percent black spruce forests and woodlands, and 23 percent white spruce forests and woodlands. Deciduous scrub shrub wetlands that would be affected are more diverse with 10 percent alder and alder-willow shrub, 15 percent willow shrub, 21 percent dwarf birch and tussock sedge, and 46 percent ericaceous and low shrub bogs (3PPI et al. 2014). Pipeline operations could affect a total of 12 miles of streams within the 50 or 51 foot ROW of which 64 percent (8 miles) are perennial streams and 36 percent (4 miles) are intermittent streams (Table 3.11-35; 3PPI et al. 2014). Most operational impacts (90 percent) would be to flat and slope HGM classes (Table 3.11-36; 3PPI et al. 2014).

The temperature of the natural gas at the compressor station at 100°F would equilibrate and remain close to ambient soil temperatures as it travels along most of the pipeline route (Donlin Gold 2013a). Operation of the natural gas pipeline at the designed 50 MMSCFD would cause increases in soil temperatures above the ambient 50°F soil temperatures in late summer within a zone of about 20 miles from the compressor station; and would cause changes in the ambient 32°F soil temperatures within zones of about 10 to 15 miles where the pipeline temperature would be either above the soil temperature near MP 84.2 or below the soil temperature near MP 243 as the pipeline crosses into and out of permafrost soils. (Donlin Gold 2013a). Pipeline operations would cause increases in soil temperatures above the ambient 30°F soil temperatures in late winter within a zone of about 10 miles from the compressor station; and would cause an increase in the ambient 20°F soil temperature within a zone of a few miles near MP 50 where soils become colder (Donlin Gold 2013a).

Table 3.11-34: Alternative 2 Winter Access Corridor Preliminary Calculation of Potential Wetland Impacts from Winter Access Route Vegetation Clearing

Wetland Category	Route (acres)						Total Area[1] (acres)
	Oil Well Road	Deep Creek	Bear Creek	Kutna	Alexander	Big Bend Trail	
Evergreen Forested Wetlands	16.6	2.7	7.4	4.8	2.8	6.4	40.7
Deciduous Forested Wetlands	0.4	0.6	0.5	0.4	0	6.7	8.5
Mixed Forested Wetlands	3.7	3.2	1.3	0	0	0	8.3
Evergreen Scrub Shrub Wetlands	13.9	1.4	7.6	0.4	0	2.7	26.1
Deciduous Scrub Shrub Wetlands	55.8	8.9	22.4	26.9	18.3	52.5	184.8
Fen (ESB – SB)	30.9	4.6	4.4	UK	0.1	UK	40.0
Bog (LSB)	19.7	2.6	16.2	UK	0.2	UK	38.6
Herbaceous Wetlands	4.2	1.2	0.1	3.3	4.8	0.8	14.4
Ponds	0.4	0	0	0	0	0.0	0.4
Rivers	4.3	0.1	0.0	0	0	9.9	14.3
Uplands	66.5	10.3	8.4	0.3	31.1	0	116.7
Area (acre)	165.8	28.4	47.7	36.1	57.1	79.1	414.2
Wetland Area	94.6	18.0	39.3	35.7	25.9	69.2	297.5
Estimated Potential Clearing (% of Route)	43%	58%	95%	90%	100%	72%	NA
Potential Wetland Clearing (acres)	40.7	10.4	37.3	32.2	25.9	49.8	196.3

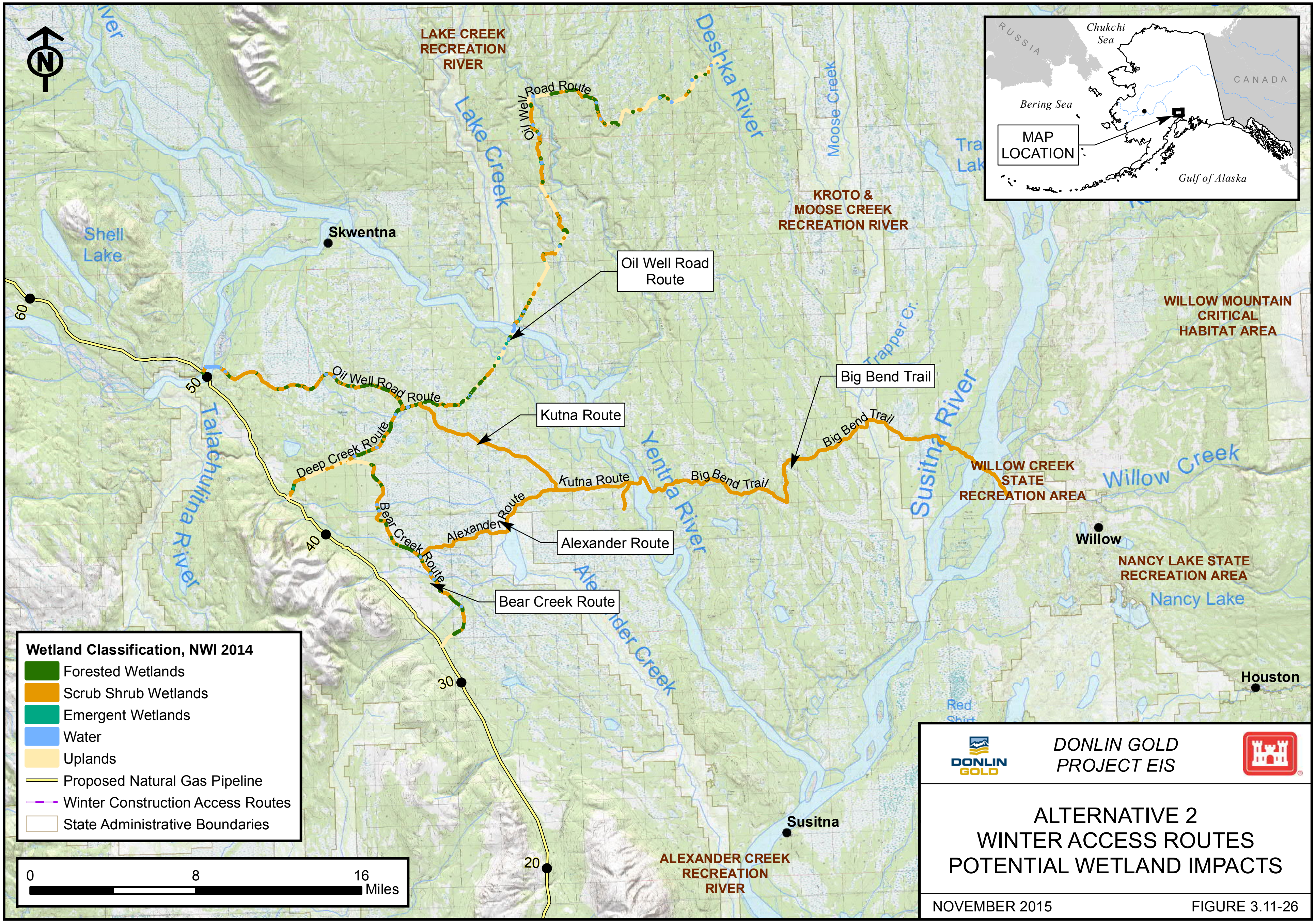
Notes:

1 Estimated clearing impacts within 30-foot wide access road based on the proportion of the access route that does not appear to be collocated with an existing trail based on a review of current aerial imagery. Additional clearing to widen existing trails from current 10 feet or 15 feet widths to 30 feet wide was not estimated.

NA = Not Applicable

UK = Unknown
0 = None
0.0 = < 0.1
ESB – SB = Ericaceous Shrub Bog – String Bog
LSB = Low Shrub Bog

Source: 3PPI et al. 2014, FWS 2014a (NWI)



ALTERNATIVE 2
WINTER ACCESS ROUTES
POTENTIAL WETLAND IMPACTS

NOVEMBER 2015

FIGURE 3.11-26

In general, increased soil temperatures during early spring would be expected to result in earlier germination and emergence in wetland plant species while decreased soil temperatures would be expected to result in delayed germination and emergence. Experimental effects of increased soil temperature on prairie wetland plants and seed banks found that stem density, biomass, and species richness for annual plants increased with increasing soil temperatures while species richness for perennial plants showed a small positive increase (Seabloom et al. 1998). Twenty years after installation of a natural gas pipeline through a boreal forest in Wisconsin, Zimmerman et al. (1993) found: adjacent wetland areas were not altered in type; sheet flow restriction had been reversed naturally; no non-native plants had invaded the natural area; 75 percent of the ROW area was wetland; and the ROW increased overall vegetation diversity. The pipeline may also cause slight increases in water temperatures where the pipeline crosses through wetlands near the compressor station. Effects would be most pronounced in small ponds and wetlands, as excess heat would dissipate in larger water bodies and flowing waters. Small ponded wetlands over the pipeline may freeze later and thaw sooner than surrounding wetlands. Potential pipeline operations impacts on streams may include the potential for localized chilled pipeline sections that could result in the formation of ice dams and aufeis, which are discussed in Section 3.5, Surface Water Quality. Ground surface disturbances can also create conditions that lead to aufeis formation. Bedding materials, construction materials such as liners, or the pipeline can create a subsurface blockage of shallow groundwater flow causing the ground water to seep from the ground. In most cases adverse aufeis conditions generated by the pipeline would be corrected to ensure the structural integrity of the pipeline and would result in little if any impact to wetland vegetation as discussed in Section 3.5, Surface Water Quality.

Table 3.11-35: Alternative 2 Pipeline Operations and Maintenance Preliminary Calculation of Wetland Direct Impacts by Ecoregion

Wetland Category	Ecoregion (acres)				Impact Area[1] (acres)
	Kuskokwim Mountains	Tanana-Kuskokwim Lowlands	Alaska Range	Cook Inlet Basin	
Evergreen Forested Wetlands	68.5	120.0	131.2	12.3	332.0
Deciduous Forested Wetlands	3.7	3.1	0.4	18.1	25.3
Mixed Forested Wetlands	17.2	29.1	3.2	47.1	96.7
Evergreen Scrub Shrub Wetlands	47.8	70.3	16.2	7.6	142.0
Deciduous Scrub Shrub Wetlands	86.3	176.1	105.1	59.9	427.3
Fen (ESB – SB)	0.5	0	0.0	0.3	0.9
Bog (LSB)	15.4	77.4	5.2	8.7	106.8
Herbaceous Wetlands	2.7	11.5	4.2	10.0	28.3
Ponds	0.2	0.2	0.1	0.1	0.6
Lakes	0	0.1	0.0	0.0	0.1
Rivers	2.3	6.4	7.3	1.5	17.5
Intermittent Streams (miles)	0.7	1.6	1.2	0.9	4.4

Table 3.11-35: Alternative 2 Pipeline Operations and Maintenance Preliminary Calculation of Wetland Direct Impacts by Ecoregion

Wetland Category	Ecoregion (acres)				Impact Area[1] (acres)
	Kuskokwim Mountains	Tanana-Kuskokwim Lowlands	Alaska Range	Cook Inlet Basin	
Perennial Streams (miles)	2.1	2.4	0.8	2.6	7.8
Uplands	535.3	189.7	442.3	497.2	1,664.5
Area	763.9	606.5	710.1	653.9	2,734.3
Wetland Area	226.1	410.1	260.3	155.1	1,051.6

Notes:

1 Operations impact area defined as the 50-foot or 51-foot right-of-way, access roads to airstrips and facilities, airstrips, compressor station, fault crossings, distribution station, pig launcher, and metering station; assumes all construction-related disturbances (camps, material sources, work pads, storage yards and associated access roads) would reclaimed.

2 Proportion of impact area in pipeline wetland study area by wetland category. Note that mosaic classes calculated as 100% wetlands overestimates the wetland area.

0 = None
0.0 = < 0.1
ESB – SB = Ericaceous Shrub Bog – String Bog
LSB = Low Shrub Bog

Source: 3PPI et al. 2014.

Table 3.11-36: Alternative 2 Pipeline Operations and Maintenance Preliminary Calculation of Wetland Direct Impacts by HGM Class

Wetland Category	HGM Class (acres)							Impact Area[1] (acres)	Study Area (acres)	Area[2] (%)
	Depression	Flat	Slope	Riverine	River Channel	Lacustrine	Lake Fringe			
Evergreen Forested Wetlands	0.5	246.9	74.6	10.1	0	0	0.0	332.0	12,546.3	43%
Deciduous Forested Wetlands	0.3	5.1	17.8	2.0	0	0	0	25.3	1,004.5	3%
Mixed Forested Wetlands	0	28.0	36.2	32.6	0	0	0	96.7	3,937.2	52%
Evergreen Scrub Shrub Wetlands	0.2	92.0	47.7	2.1	0	0	0	142.0	6,953.9	32%
Deciduous Scrub Shrub Wetlands	2.5	230.4	162.9	31.5	0	0	0.0	427.3	23,134.0	2%
Fen (ESB – SB)	0	0	0.9	0	0	0	0	0.9	1,797.5	<1%
Bog (LSB)	0.7	62.6	42.7	0.7	0	0	0	106.8	6,473.5	2%
Herbaceous Wetlands	3.1	7.7	14.8	2.6	0	0	0.1	28.3	1,868.6	2%
Ponds	0.4	0	0	0.2	0	0	0	0.6	413.6	<1%
Lakes	0	0	0	0	0	0.1	0.0	0.1	151.9	<1%
Rivers	0	0	0	0	17.5	0	0	17.5	2,135.0	1%
Intermittent Streams (miles)	NA	NA	NA	NA	NA	NA	NA	4.4	202.8	2%
Perennial Streams (miles)	NA	NA	NA	NA	NA	NA	NA	7.8	306.8	3%
Uplands	NA	NA	NA	NA	NA	NA	NA	1,664.5	57,864.5	53%
Area	6.9	610.0	354.1	81.1	17.5	0.1	0.1	2,734.3	110,010.6	42%
Wetland Area	1%	57%	33%	8%	2%	<1%	<1%	1,051.6	49,444.6	2%

Notes:

1 Operations impact area defined as the 50-foot or 51-foot right-of-way, access roads to airstrips and facilities, airstrips, compressor station, fault crossings, distribution station, pig launcher, and metering station; assumes all construction-related disturbances (camps, material sources, work pads, storage yards and associated access roads) would reclaimed.

2 Proportion of impact area in pipeline wetland study area by wetland category. Note that mosaic classes calculated as 100% wetlands overestimates the wetland area.

NA = Not applicable 0 = None 0.0 = < 0.1 ESB – SB = Ericaceous Shrub Bog – String Bog LSB = Low Shrub Bog

Source: 3PPI et al. 2014.

Although in general a smaller area of wetlands would be affected by operations, potential effects within the operational ROW would be longer term. Between 2 and 3 percent of pipeline study area wetlands rated high for each of the four hydrologic functions could be altered by pipeline operations (Table 3.11-37, Appendix K, Tables K-14 and K-15; 3PPI 2014b). Altered hydrologic functions could extend effects to the streams connected to or downstream from the affected wetlands. Maintenance vegetation clearing with no ground disturbance could reduce wetlands capacity for modification of water quality and export of detritus biogeochemical functions especially for riverine deciduous forested or scrub shrub wetlands. About 2 to 3 percent of study area wetlands rated as high functioning for the two biogeochemical functions may experience a reduction in these functions (Table 3.11-37). The areas of potential operational effects on moderate and high functioning wetlands within each ecoregion are illustrated in Figure 3.11-27, Figure 3.11-28, and Figure 3.11-29.

Table 3.11-37: Alternative 2 Pipeline Operations and Maintenance Preliminary Calculation of Wetland Direct Impacts by Preliminary Wetland Function Ratings

Wetland Function Models	FCI Model Rating	Impact Area (acres)	Study Area[1] (acres)	Area[2] (%)	Impact Criteria (Magnitude)
Hydrologic Functions					
Modification of Groundwater Discharge	Low	37.9	811.1	5%	Medium
	Mod	917.1	41,233.1	2%	Low
	High	94.5	3,260.6	3%	Low
Modification of Groundwater Recharge	Low	0	8.1	0%	Low
	Mod	578.0	22,820.7	3%	Low
	High	103.3	4,935.6	2%	Low
Storm and Floodwater Storage	Low	0.0	10.0	0%	Low
	Mod	207.4	7,349.3	3%	Low
	High	842.2	37,974.1	2%	Low
Modification of Stream Flow	Low	151.8	20,752.9	1%	Low
	Mod	140.9	3,723.7	4%	Low
	High	74.4	2,249.5	3%	Low
Biogeochemical Functions					
Modification of Water Quality	Low	0.3	67.9	1%	Low
	Mod	8.3	621.7	1%	Low
	High	1,041.0	44,643.7	2%	Low
Export of Detritus	Low	113.8	14,842.8	1%	Low
	Mod	33.7	4,114.4	1%	Low
	High	261.0	8,611.9	3%	Low

Table 3.11-37: Alternative 2 Pipeline Operations and Maintenance Preliminary Calculation of Wetland Direct Impacts by Preliminary Wetland Function Ratings

Wetland Function Models	FCI Model Rating	Impact Area (acres)	Study Area[1] (acres)	Area[2] (%)	Impact Criteria (Magnitude)
Biological Functions					
Abundance and Diversity of Wetland Flora	Low	0.5	19.1	3%	Low
	Mod	22.1	965.8	2%	Low
	High	1,027.5	44,360.8	2%	Low
Abundance and Diversity of Wetland Fauna	Low	0.5	12.4	4%	Low
	Mod	372.5	18,861.0	2%	Low
	High	677.1	26,472.3	3%	Low

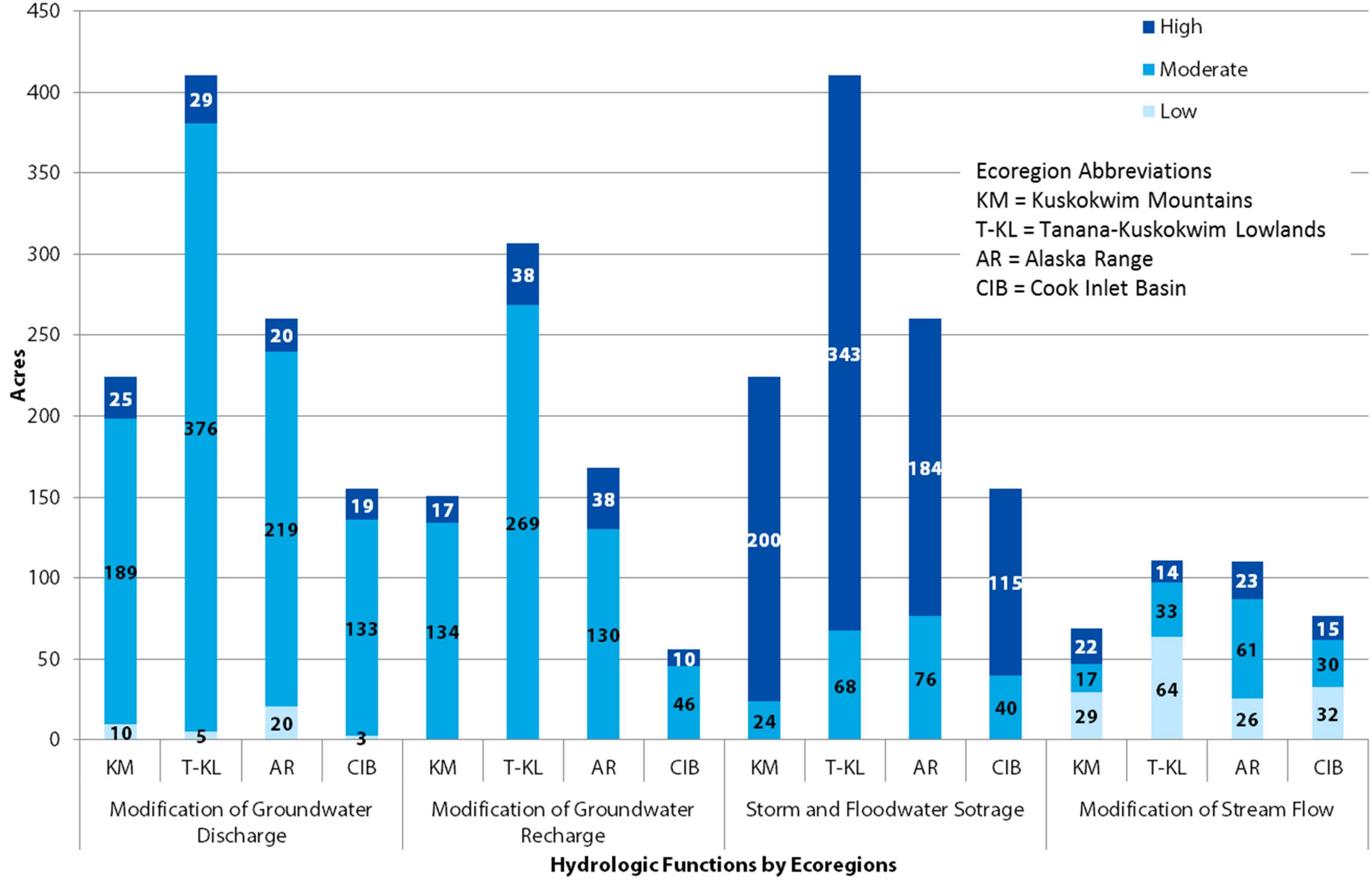
Notes:

1 Totals reflect 81% of pipeline wetland study area included in the wetland functional assessment (3PPI 2014b).

2 Proportion of potential impact area within the pipeline wetland study area rated for wetland functions by Functional Capacity Index (FCI) rating (Low > 0 and < 0.33; Moderate (Mod) ≥ 0.33 and < 0.66; High ≥ 0.66). Note that mosaic classes calculated as 100% wetlands overestimates the wetland area.

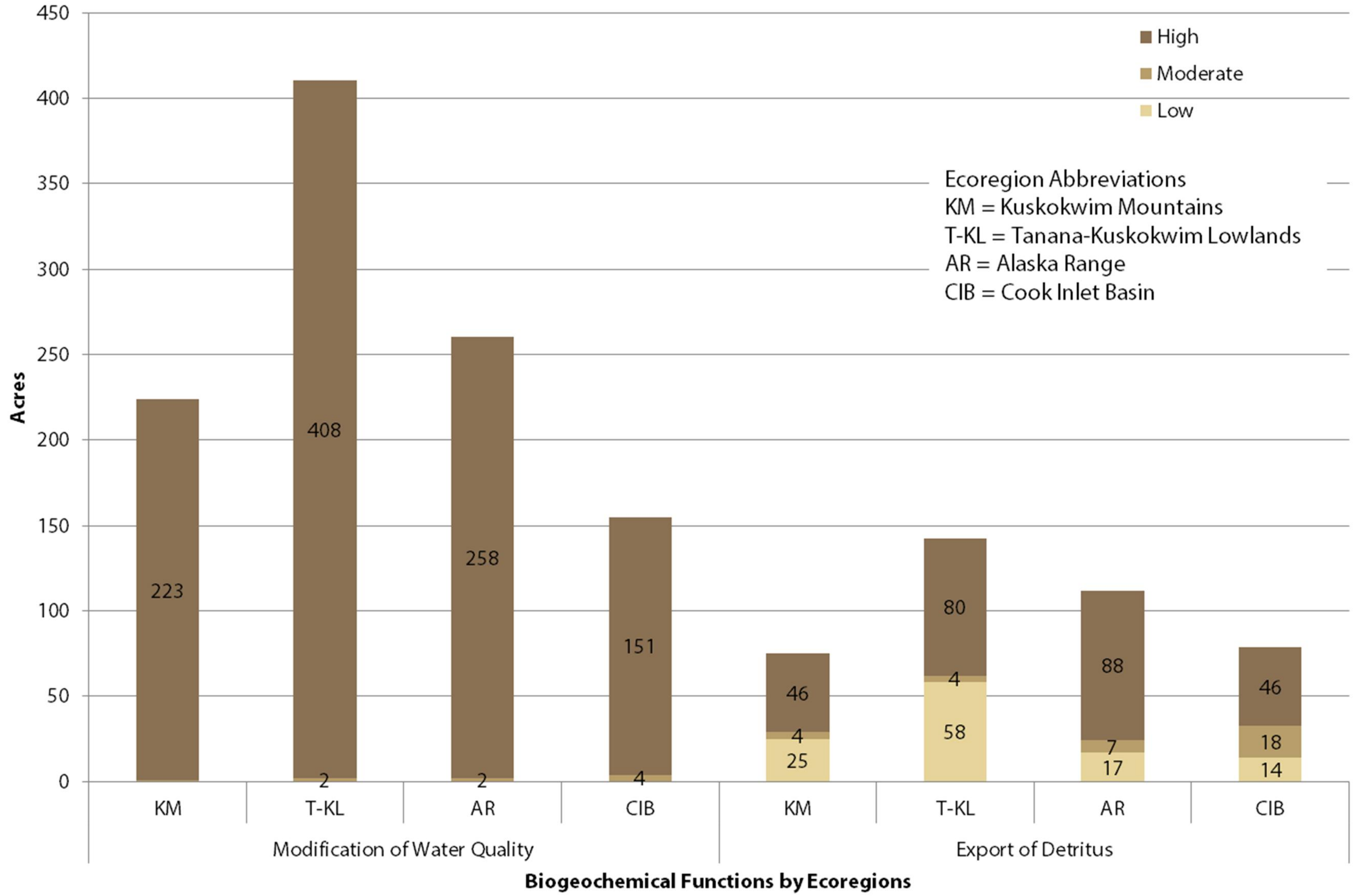
NA = Not Applicable
0 = None
0.0 = < 0.1

Source: 3PPI 2014b.



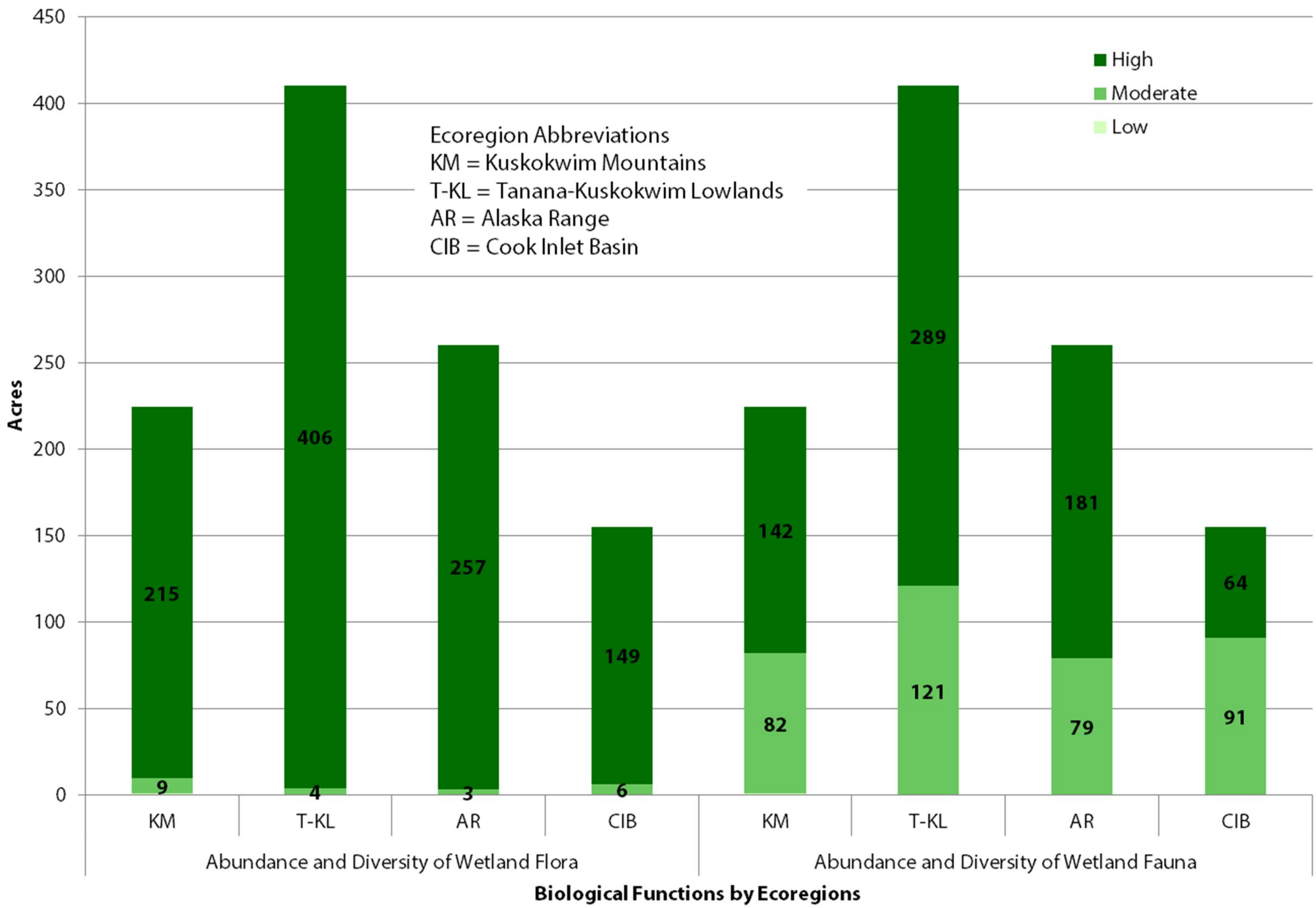
Source: 3PPI 2014b.

Figure 3.11-27: Alternative 2 Pipeline Operations Wetland Impacts for Hydrologic Functional Capacity by Ecoregion



Source: 3PPI 2014b.

Figure 3.11-28: Alternative 2 Pipeline Operations Wetland Impacts for Biogeochemical Functional Capacity by Ecoregion



Source: 3PPI 2014b.

Figure 3.11-29: Alternative 2 Pipeline Operations Wetland Impacts for Biological Functional Capacity by Ecoregion

Closure and Reclamation

Reclamation of the pipeline construction corridor would immediately follow construction. All roads, new airstrips, and barge landings used for pipeline construction would be reclaimed post-construction. Road culverts would be removed, natural drainage areas would be restored or stabilized, erosion control structures would be installed, and road beds would be graded where necessary to provide drainage. Most flat to gently sloping wetlands would be reclaimed by removal of fill. Fill would not likely be removed in areas where marginal hydrology makes restoration of wetlands not feasible. The pipeline would be decommissioned in place with removal of all above-ground facilities. All above-ground pipeline components and the transmission line would be removed and the sites would be reclaimed. The buried pipeline and fiber optic cable would be abandoned in place. Removal and reclamation of the pipeline components and transmission line would include some minor land disturbance activities which would be reclaimed as described for construction.

Avoidance, Minimization, and Compensatory Mitigation

Donlin Gold has incorporated procedures to be implemented during pipeline routing, construction, operations, and closure designed to avoid and minimize adverse impacts to wetlands; and has committed to provide compensation for unavoidable wetland impacts. During final pipeline project design Donlin Gold would develop project-specific stabilization, rehabilitation, and reclamation and an Invasive Species Management Plan in consultation with the ADNR, the ADF&G, and the BLM to address all disturbed areas and to further identify ice-rich permafrost areas requiring special attention. Applicable measures for avoidance and minimization of potential wetland impacts are outlined in the Natural Gas Pipeline Plan of Development (SRK 2013b). Avoidance of wetlands was integrated into initial pipeline routing to avoid or route around wetlands by using ridge-tops and non-wetland areas. Wetland impact minimization was incorporated into the project design by reducing the construction footprint in areas near wetlands where avoidance was not practicable. Construction minimization measures would also include incorporation of slope stabilization to prevent sediments from entering wetlands, limiting use of earth moving equipment to upland areas during construction, and use of large surface area / low impact tires for equipment operating on or near wetlands.

The use of traditional wetland construction methods would minimize construction-related effects on wetlands and would help prevent long-term effects on wetland functions. Traditional wetland measures may include:

- Mark wetland boundaries and vegetation clearing limits;
- Schedule pipeline construction across wetlands during winter to the maximum extent practicable;
- Confine activities to the construction zone to prevent disturbance of surrounding vegetation;
- Maintain slope stability;
- Control erosion;
- Use mats or other types of ground protection during non-winter construction;
- Maintain existing wetland hydrology;

- Avoid and minimize ground-disturbing activity in wetland habitats;
- Reestablish wetland vegetation that is typical of the general area, where practicable;
- Use large surface area/low impact tires to help reduce equipment impacts on or near wetlands; and
- Limit permanent facilities including compressor stations, access roads, and work pads to non-wetland areas to the maximum extent practicable.

Other wetland-specific procedures incorporated into the project would include:

- Reduction of the construction ROW width to 85 feet where mats are required;
- Frost-pack muskegs and wetlands;
- Salvage and replacement of the native vegetation mat in wetlands;
- Installation of trench plugs in hilly terrain to maintain wetland hydrology;
- Installation of streambank protection such as geotextile matting, riprap armoring or methods from ADF&G's Streambank Revegetation and Protection Manual (Walter et al. 2005); and
- Post-construction monitoring to ensure regrowth and stability (SRK 2013b).

Stabilization of the trench would be a multi-year process in some locations, especially in areas with fine grained ice-rich soils and in wetland areas. The primary compensation for wetland damage caused by the pipeline construction would be reclamation of the ROW to reestablish wetlands and wetland functions. Site-specific best management practices would be identified and applied. Where losses would be permanent with no possibility for restoration, compensatory mitigation could be developed collaboratively with the Corps and other federal, state and local agencies and landowners. Donlin Gold's conceptual CMP has identified potential compensatory mitigation mechanisms for unavoidable loss of wetlands (Table 3.11-38). Mitigation is further discussed in Chapter 5, Impact Avoidance, Minimization, and Mitigation.

Table 3.11-38: Alternative 2 Pipeline Potential Compensatory Mitigation Mechanisms for Losses of Aquatic Resources

Mitigation Type	Status	Description	Potential Compensation Area
Mitigation Bank			
Kuskokwim River Mitigation Bank	POA-2014-028; In Review	Sponsored by Calista, the Kuskokwim River Umbrella Mitigation Bank, if approved, would cover the service area for a portion of the pipeline, and could be used to purchase credits for the permanent and temporal impacts in waters of the U.S. within the Kuskokwim River region. The Donlin Gold Project is located within the Aniak subbasin (HUC 8-190301) where the Fuller Creek Mitigation Bank (10,880 acres) is proposed.	23,000 acres
Su-Knik Mitigation Bank	POA-2006-1608	Sponsored by the Matanuska-Susitna Borough and Sustainable Environments, LLC, the Su-Knik Mitigation Bank, would cover the service area for the pipeline, and could be used to purchase credits for the permanent and temporal impacts in waters of the U.S. within the Yentna River sub-basin (HUC 8-19020504) and the Lower Susitna River sub-basin (HUC 8-19020505).	12,756 acres
Pioneer Reserve LLC	POA-2010-147	Sponsored by Mitigation Solutions USA, the Pioneer Mitigation Bank, would cover the service area for the pipeline, and could be used to purchase credits for the permanent and temporal impacts in waters of the U.S. within the Susitna River basin (HUC 6-190205), including the Yentna River sub-basin (HUC 8-19020504) and the Lower Susitna River sub-basin (HUC 8-19020505).	235 credits
In-Lieu Fee Program			
Alaska In-Lieu Fee Compensatory Mitigation Program	Inactive	Sponsored by The Conservation Fund, the in-lieu fee program was issued advance credits within the Interior Alaska Region.	Currently 0 acres

Source: Michael Baker International 2015.

Summary of Impacts for Natural Gas Pipeline

Anticipated Alternative 2 pipeline construction effects on wetlands would be medium in intensity with 5 percent of wetlands affected and a potential reduction in functional capacity for 5 to 8 percent of high functioning wetlands for each evaluated function within the pipeline wetland study area (Table 3.11-31 and Table 3.11-32). While construction-related effects would have a medium intensity, operations-related effects would generally be low in intensity (Table 3.11-36 and Table 3.11-37). Many construction-related effects on wetlands would be short-term, because reclamation and restoration would begin soon after construction. Because of the extended recovery time for boreal forest wetlands, expected short-term effects may become long-term or permanent. While most wetlands would be restored, functions may be reduced for extended periods. About 21 percent of the pipeline ROW would cross permafrost-based wetlands; 8 percent of which are on unstable permafrost soils which may be difficult to restore as wetlands (Table 3.11-33). Most permafrost-based wetlands would be crossed during winter to minimize disturbance from trenching. The geographic extent of wetland impacts from the pipeline would be regional (affecting small areas of wetlands across multiple watersheds). Much of the wetland area impacted by the pipeline construction and operations contains high functioning wetlands for storm and floodwater storage, modification of water quality, and contribution to the abundance and diversity of wetland flora and fauna (Table 3.11-32 and Table 3.11-37, and Figure 3.11-27, Figure 3.11-28, and Figure 3.11-29). These high functioning wetlands include wetlands supporting anadromous fish streams, a few fen and bog wetlands, and regionally scarce open water lakes and ponds. The overall impact of the construction, operations, closure, and reclamation of the natural gas pipeline for Alternative 2 on wetlands would be considered moderate (Table 3.11-39).

Table 3.11-39: Alternative 2 Pipeline Summary of Preliminary Calculation of Wetland Direct Impacts

Wetland Category	Pipeline Construction Impact Area[1] (acre)	Pipeline Operations and Maintenance Impact Area[2] (acre)
Evergreen Forested Wetlands	701.0	332.0
Deciduous Forested Wetlands	55.6	25.3
Mixed Forested Wetlands	252.3	96.7
Evergreen Scrub Shrub Wetlands	323.5	142.0
Deciduous Scrub Shrub Wetlands	948.2	427.3
Fen (ESB – SB)	5.9	0.9
Bog (LSB)	226.8	106.8
Herbaceous Wetlands	58.8	28.3
Ponds	1.4	0.6
Lakes	0.4	0.1

Table 3.11-39: Alternative 2 Pipeline Summary of Preliminary Calculation of Wetland Direct Impacts

Wetland Category	Pipeline Construction Impact Area[1] (acre)	Pipeline Operations and Maintenance Impact Area[2] (acre)
Rivers	34.7	17.5
Intermittent Streams (miles)	7.8	4.4
Perennial Streams (miles)	13.3	7.8
Wetland Area	2,339.9	1,051.6

Notes:

1 See Figure 3.11-24 for breakdown by HGM class.

2 Operations impact area defined as the 50 foot or 51 foot right-of-way, access roads to airstrips and facilities, airstrips, compressor station, fault crossings, distribution station, pig launcher, and metering station; assumes all construction-related disturbances (camps, material sources, work pads, storage yards) would reclaimed; see Table 3.11-36 for breakdown by HGM class.
0 = None

ESB – SB = Ericaceous Shrub Bog – String Bog
LSB = Low Shrub Bog

Source: 3PPI et al. 2014.

3.11.4.2.4 CLIMATE CHANGE SUMMARY FOR ALTERNATIVE 2

Predicted overall increases in temperatures and precipitation and changes in the patterns of their distribution (McGuire 2015; Chapin et al. 2006, 2010; Walsh et al. 2005) have the potential to influence the projected effects of the Donlin Gold Project on vegetation and wetlands. An overall warming/drying trend would tend to convert some wetlands to uplands and tend to increase the cover of shrubs and trees in previously open areas. Warming may also increase the thawing of permafrost over time. In Project areas like the pipeline, increased thawing might lead to more open water areas. Permafrost thaw may cause ground subsidence leading to water-filled depressions. Adjacent areas may then drain, causing a shift from a wetland type or mosaic to an upland type. Higher transpiration, less available water, and a lower albedo caused by woody vegetation increase contributes to a drier landscape with fewer or smaller waterbodies compared to current conditions. Large scale hydrological changes may occur throughout the landscape. See Section 3.26 (Climate Change) for further details on climate change and resources.

3.11.4.2.5 SUMMARY OF IMPACTS FOR ALTERNATIVE 2

The anticipated direct and indirect effects on wetlands from all the components of Alternative 2 would be generally medium in intensity, long-term to permanent in duration, local to regional in extent, and primarily common in context with some effects on important wetland resources (Table 3.11-40). The impact of the construction, operations, closure, and reclamation for Alternative 2 on wetlands would be considered moderate as defined in Section 3.11.4.

Table 3.11-40: Summary of Impacts to Wetlands for Alternative 2

Impacts	Impact Levels				
	Magnitude or Intensity	Duration	Geographic Extent	Context	Summary Impact Rating[1]
Mine Site					
Direct Wetland Impacts	Medium to High	Long-term	Local	Common to Important	Moderate
Potential Indirect Wetland Impacts	Medium	Long-term	Local	Common to Important	Moderate
Transportation Facilities					
Direct Wetland Impacts	Low	Long-term	Local	Common to Important	Minor
Potential Indirect Wetland Impacts	Low to Medium	Long-term	Local	Common to Important	Minor
Potential Barge Wake Erosion Impacts	Low to Medium	Medium-term	Regional	Important	Moderate
Pipeline					
Direct Construction Wetland Impacts	Medium	Short- to Long-term	Regional	Common to Important	Moderate
Direct Operations Wetland Impacts	Low	Long-term	Regional	Common to Important	Moderate

Notes:

1 The summary impact rating accounts for impact reducing design features proposed by Donlin Gold and Standard Permit Conditions and BMPs that would be required. It does not account for additional mitigation measures the Corps is considering.

These effects determinations take into account impact reducing design features (Table 5.2-1 in Chapter 5, Impact Avoidance, Minimization, and Mitigation) proposed by Donlin Gold and also the Standard Permit Conditions and BMPs (Chapter 5, Impact Avoidance, Minimization, and Mitigation) that would be implemented. Several examples of these are presented below.

Design features most important for reducing impacts to wetlands include:

- Where feasible, valley bottom and lowland material sites would be reclaimed to create new wetland areas with ponds and emergent vegetation or black spruce wetlands;
- The project design includes developing multiple use facilities – using the same piece of ground for more than one purpose over the life of the mine as well as using existing disturbed areas for temporary construction activities to the maximum extent practicable;
- Material site selections would take into consideration potential for conversion to wetlands or restoration to higher functioning wetlands;
- Geosynthetic liner would be used over permafrost in wetland areas to minimize thawing or degradation that could lead to requirements of excessive amounts of fill to avoid shoulder sloughing; and

- Design mine transportation facilities, site access routes, airstrips and other transportation infrastructure along ridge tops whenever possible to minimize wetlands and stream impacts.

Standard Permit Conditions and BMPs most important for reducing impacts to wetlands include:

- Implementation of Stormwater Pollution Prevention Plans (SWPPPs) and/or Erosion and Sediment Control Plans; and
- An Invasive Species Management Plan (ISMP).

Additional Mitigation and Monitoring for Alternative 2

The Corps is considering additional mitigation (Table 5.5-1 in Chapter 5, Impact Avoidance, Minimization, and Mitigation) to reduce the effects presented above. These additional mitigation measures include:

- Train site construction managers to oversee work of specialists in wetland recognition, permit stipulations, and BMPs;
- Use mats or other appropriate types of ground protection to minimize disturbance to ground vegetative cover during non-winter construction;
- Salvage and replace the native vegetation mat in wetlands, and/or reestablish wetland vegetation that is typical of the general area, where practicable;
- Mark wetland boundaries and vegetation clearing limits with flagging or other markers to prevent crews from damaging more vegetation than needed during construction; and
- Use large surface area/low impact tires on or near wetlands to help reduce equipment impacts.

The Corps is considering additional monitoring (Table 5.7-1 in Chapter 5, Impact Avoidance, Minimization, and Mitigation) to reduce the effects presented above. These additional monitoring measures include:

- Monitoring of bank erosion upstream and downstream of Angyaruaq (Jungjuk) Port and consideration of streambank protection as part of adaptive management plan if warranted. This may include installation of geotextile matting, riprap armoring or methods from ADF&G's Streambank Revegetation and Protection Manual (Walter et al. 2005) to reduce the effects of eddy formation, scour, and bank erosion during flood events (BGC 2014e).

If these mitigation and monitoring measures were adopted and required, the summary impact rating for the mine site and transportation facilities would be somewhat reduced, but would remain moderate. The impacts from the natural gas pipeline could be reduced to minor in some locations but would primarily be moderate. Further compensatory wetland mitigation is being considered by the Corps to offset unavoidable impacts, as outlined in the Conceptual Mitigation Plan in Appendix M, Compensatory Mitigation Plan.

3.11.4.3 ALTERNATIVE 3A – REDUCED DIESEL BARGING: LNG-POWERED HAUL TRUCKS

Alternative 3A would replace diesel fuel with LNG to power the mine haul trucks. Alternative 3A would require construction of an LNG plant and storage tanks near the ore processing plant. It would result in reduced diesel consumption, reduced barge trips, and reduced onsite diesel storage. It would increase natural gas usage, but would not increase the size of the pipeline.

Mine Site – Construction; Operations and Maintenance; and Closure, Reclamation, and Monitoring

The LNG plant, storage containers, and distribution infrastructure footprint would occur within an area that would be disturbed under Alternative 2; therefore, no new impacts to wetlands are anticipated. Mine site closure, reclamation, and monitoring would be the same as for Alternative 2.

Transportation Facilities – Construction; Operations and Maintenance; and Closure, Reclamation, and Monitoring

After the end of construction, there would be a reduction in the amount of diesel required for the project and hence, the number of fuel barge trips compared to Alternative 2. There would also be a reduction in the number of truck trips between the port and the mine site, which may lessen but would not eliminate indirect effects on wetlands from dust and gravel spray along the road. Potential indirect effects on wetlands from construction of diesel storage tanks at Dutch Harbor and Bethel could also be reduced or eliminated with the reduced need to transfer and store diesel fuel at these ports.

The estimated barge traffic on the Kuskokwim River would be reduced from 122 to 83 round trips, which would reduce seasonal wake energy (Table 3.11-41 and Table 3.11-28) and would also reduce the potential for spills. Fuel barge trains generate between 150 to 400 percent more wake energy on their downstream transit than do upriver bound cargo barge trains (BGC 2007c). Projected increases in wetland erosion rates resulting from barge wake energy may be less under Alternative 3A than under Alternative 2.

Table 3.11-41: Alternative 3A Projected Barge-Related Wetland Erosion Rates

Wetland Type	Kuskokwim River Segments			
	Mouth to Bethel	Tuluksak	Kalskag	Aniak to Napaimute
Annual Erosion Rates (acres/mile/year)				
Estuarine and Marine Wetland	4.92	0.00	0.00	0.00
Freshwater Emergent Wetland	3.64	0.03	0.09	0.00
Freshwater Forested/Shrub Wetland	0.51	1.76	0.37	0.17
All Wetlands	9.07	1.79	0.45	0.17

Table 3.11-41: Alternative 3A Projected Barge-Related Wetland Erosion Rates

Wetland Type	Kuskokwim River Segments			
	Mouth to Bethel	Tuluksak	Kalskag	Aniak to Napaimute
Projected Annual Wetland Erosion Rate Increase (acres/mile/year)[1]				
Seasonal Wake Energy/River Tractive Energy	1.3%	1.6%	4.1%	3.5%
Estuarine and Marine Wetland	0.05	0	0	0
Freshwater Emergent Wetland	0.05	0.00	0.00	0.00
Freshwater Forested/Shrub Wetland	0.01	0.03	0.02	0.01
All Wetlands	0.12	0.03	0.02	0.01

Notes:

1 Seasonal erosion rate calculated from 18-year erosion measure divided by 18 years to give an annual erosion rate (ARCADIS 2007a); increase in wave energy based on 19 fuel and 64 cargo river barge trips per season based on BGC (2007c, Table 8).

Source: Analysis based on ARCADIS 2007a; BGC 2007c; FWS 2014a.

Pipeline – Construction; Operations and Maintenance; and Closure, Reclamation, and Monitoring

The natural gas pipeline for Alternative 3A would be essentially the same as Alternative 2; therefore, potential impacts to wetlands would be the same between these two alternatives.

Summary of Impacts for Alternative 3A

Alternative 3A would result in mine site and pipeline wetland impacts that would be essentially the same as Alternative 2. The overall impact of the mine site and natural gas pipeline on wetlands would be moderate for Alternative 3A, as described for Alternative 2.

The overall impact of the construction and operations of mine transportation facilities for Alternative 3A would be similar to Alternative 2, with a potential for elimination of indirect effects from port expansions under Alternative 3A. Many direct effects on wetlands would be permanent because the access road and airstrip would be retained to access the mine site post-closure for monitoring. The overall impacts of mine transportation facilities on wetlands for both alternatives would be considered minor. Reduced fuel barging under Alternative 3A could reduce potential wetland erosion increases from barge wakes to 1 to 4 percent, which would reduce the intensity to low for Alternative 3A (Table 3.11-42). Potential increases in wetland erosion rates attributable to barge wakes would be short-term in duration with reduced traffic after construction, and returning to pre-activity levels soon after barging is discontinued at mine closure. Barge activities on the Kuskokwim River would be regional in extent and would affect wetlands that are important for supporting anadromous fish streams and subsistence resources. Impacts associated with climate change would also be the same as those discussed for Alternative 2. The overall direct and indirect effects on wetlands for Alternative 3A would be considered minor.

Table 3.11-42: Summary of Impacts to Wetlands for Alternative 3A

Impacts	Impact Levels				
	Magnitude or Intensity	Duration	Geographic Extent	Context	Summary Impact Rating[1]
Mine Site					
Direct Wetland Impacts	Medium to High	Long-term	Local	Common to Important	Moderate
Potential Indirect Wetland Impacts	Medium	Long-term	Local	Common to Important	Moderate
Transportation Facilities					
Direct Wetland Impacts	Low	Long-term	Local	Common to Important	Minor
Potential Indirect Wetland Impacts	Low to Medium	Long-term	Local	Common to Important	Minor
Potential Barge Wake Erosion Impacts	Low	Short-term	Regional	Important	Minor
Pipeline					
Direct Construction Wetland Impacts	Medium	Short- to Long-term	Regional	Common to Important	Moderate
Direct Operations Wetland Impacts	Low	Long-term	Regional	Common to Important	Moderate

Notes:

1 The summary impact rating accounts for impact reducing design features proposed by Donlin Gold and Standard Permit Conditions and BMPs that would be required. It does not account for additional mitigation measures the Corps is considering.

Design features, Standard Permit Conditions and BMPs most important for reducing impacts to wetlands are described in Alternative 2. Additional mitigation and monitoring measures are also described in Alternative 2. If these mitigation measures were adopted and required, the summary impact rating would be the same as Alternative 2, primarily moderate.

3.11.4.4 ALTERNATIVE 3B – REDUCED DIESEL BARGING: DIESEL PIPELINE

Alternative 3B would supply diesel fuel for mine operations through an 18-inch diameter pipeline from Tyonek in Cook Inlet to the mine site. Reduction in barge traffic on the Kuskokwim River could reduce potential project-related impacts to wetlands as wave energy-related impacts on wetland erosion would be reduced. Reduced fuel barge traffic would also result in a reduced risk of fuel spills and potential spill-related impacts on wetland and riparian habitats. The diesel fuel pipeline would increase the total area of long-term wetlands impacts with additional access roads and airstrips for spill response and would shift much of the risk of potential diesel spill impacts on wetlands from the Kuskokwim River barge route to the diesel pipeline corridor. This alternative would require a dock in Cook Inlet near Tyonek, a barge landing, staging for spill response equipment, and tanks sufficient to store 10 million gallons of diesel fuel. The diesel pipeline would include a new 19-mile segment from the Tyonek dock to MP 0 (Figure 3.11-30). At MP 0 the diesel pipeline would follow the same 315-mile long route that was evaluated for the natural gas pipeline in Alternative 2.

Mine Site – Construction; Operations and Maintenance; and Closure, Reclamation, and Monitoring

Infrastructure at the mine site would be essentially the same as Alternative 2, with a reduction in the number of fuel storage tanks required. Storage tanks are not likely to be located on wetlands. Potential Alternative 3B impacts to wetlands for the mine site are anticipated to be the same as described in Alternative 2.

Transportation Facilities – Construction; Operations and Maintenance; and Closure, Reclamation, and Monitoring

Transportation facilities, Angyaruaq (Jungjuk) Port, and the mine access road would be similar to Alternative 2. The requirement for fuel storage at Bethel and Dutch Harbor would be eliminated. A dock extension, storage tanks, operations center and pumping station would be required near the existing Tyonek Dock (Figure 3.11-30). Fuel shipments would be by tanker to Cook Inlet instead of by barge on the Kuskokwim River. An estimated 2.5 acres of estuarine wetlands or waters would potentially be altered by construction of the dock extension (Figure 3.11-30). The tanks and operations center would be constructed on uplands (Figure 3.11-30).

Barge traffic-induced wetland erosion rates would be reduced by elimination of the need for fuel barges after the construction period; barge traffic for cargo would remain the same as Alternative 2. Estimated barge traffic would be reduced from 122 to 64 round trips, which may reduce seasonal wake energy in Alternative 3B (Table 3.11-43) and would also reduce the potential for spills.

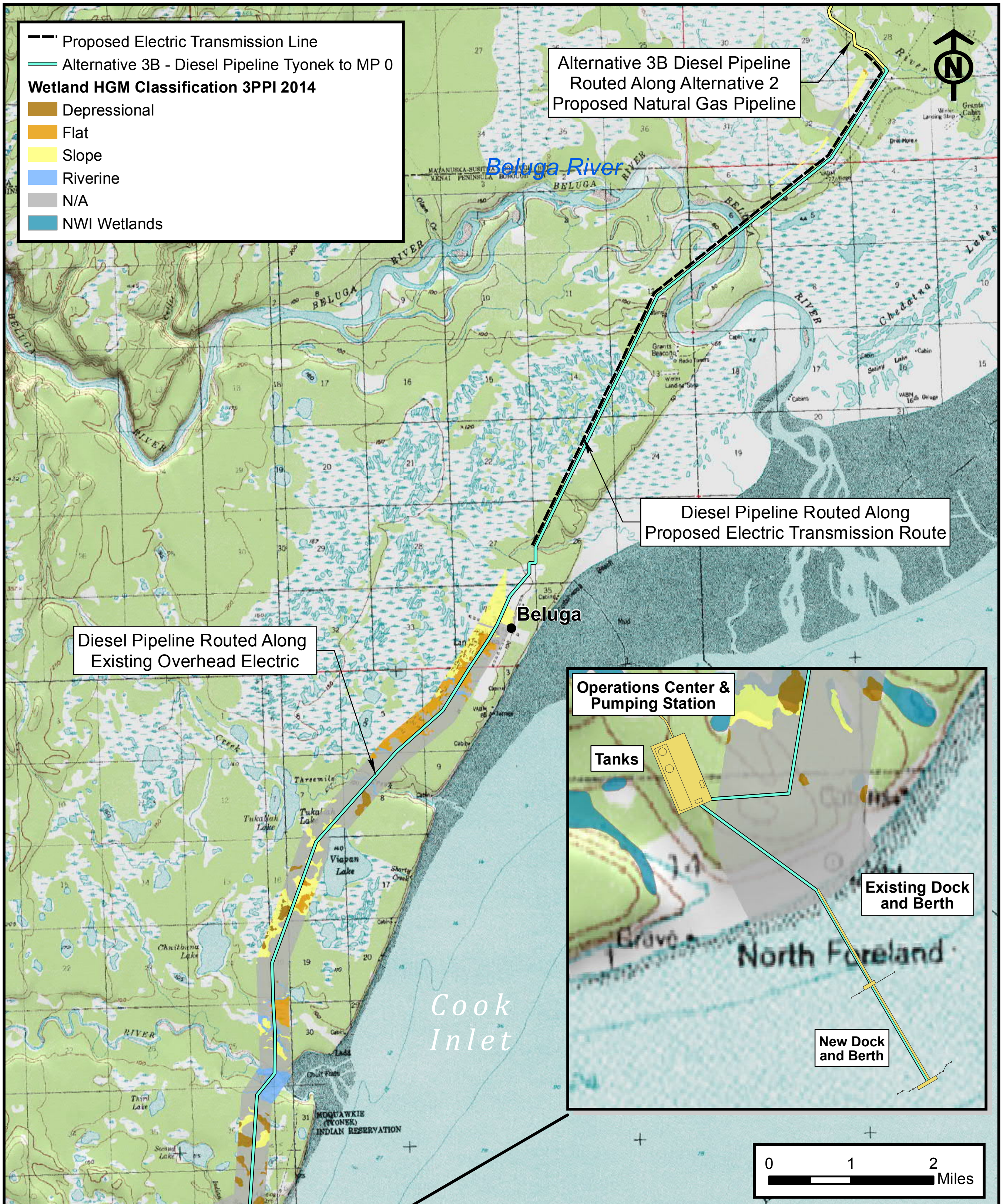
Table 3.11-43: Alternative 3B Projected Barge-Related Wetland Erosion Rates

Wetland Type	Kuskokwim River Segments			
	Mouth to Bethel	**Tuluksak**	**Kalskag**	**Aniak to Napaimute**
Annual Erosion Rates (acres/mile/year)				
Estuarine and Marine Wetland	4.92	0.00	0.00	0.00
Freshwater Emergent Wetland	3.64	0.03	0.09	0.00
Freshwater Forested/Shrub Wetland	0.51	1.76	0.37	0.17
All Wetlands	9.07	1.79	0.45	0.17
Projected Annual Wetland Erosion Rate Increase (acres/mile/year)[1]				
Seasonal Wake Energy/River Tractive Energy	0.9%	1.0%	2.8%	1.6%
Estuarine and Marine Wetland	0.04	0	0	0
Freshwater Emergent Wetland	0.03	0.00	0.00	0.00
Freshwater Forested/Shrub Wetland	0.00	0.02	0.01	0.00
All Wetlands	0.08	0.02	0.01	0.00

Notes:

1 Seasonal erosion rate calculated from 18-year erosion measure divided by 18 years to give an annual erosion rate (ARCADIS 2007a); increase in wave energy based on 64 cargo river barge trips per season based on BGC (2007c, Table 8).

Source: Analysis based on ARCADIS 2007a; BGC 2007c; FWS 2014a.



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ALTERNATIVE 3B TRANSPORTATION FACILITIES AND DIESEL PIPELINE FROM TYONEK DOCK TO MP 0

NOVEMBER 2015

FIGURE 3.11-30

Diesel Pipeline – Construction; Operations and Maintenance; and Closure, Reclamation, and Monitoring

An 18-inch diesel pipeline would be constructed instead of the natural gas pipeline along the same alignment proposed in Alternative 2, except that the pipeline would begin near Tyonek and would extend 19 miles before joining the proposed Alternative 2 pipeline route at MP 0 (Figure 3.11-30). There would also be additional requirements for block valves, long-term access roads and airstrips for spill response equipment staging for a diesel versus a natural gas pipeline. Construction of the diesel pipeline would affect an estimated 2,566 acres of wetlands, with 42 percent of impacts on deciduous shrub wetlands (Table 3.11-44). The additional 19 miles of ROW in Cook Inlet would impact an estimated 103 acres of primarily slope (55 percent) and flat (35 percent) wetlands in the Cook Inlet Ecoregion, in addition to the estimated 2,340 acres of wetlands estimated for construction of the Alternative 2 pipeline (Table 3.11-44).

Table 3.11-44: Alternative 3B Diesel Pipeline Preliminary Calculation of Wetland Direct Impacts from Construction

Wetland Category	Added Alternative 3B Impacts			Alt 2 Pipeline Impacts[3]	Alt 3B Pipeline Impacts
	18-mile ROW[1]	Airstrips[2]	Subtotal		
Evergreen Forested Wetlands	0.6	38.4	39.0	701.0	739.9
Deciduous Forested Wetlands	5.1	0	5.1	55.6	60.7
Mixed Forested Wetlands	8.0	0	8.0	252.3	260.3
Evergreen Scrub Shrub Wetlands	16.0	10.9	26.9	323.8	350.7
Deciduous Scrub Shrub Wetlands	65.7	74.2	139.9	947.9	1,087.8
Fen (ESB – SB)	12.3	0	12.3	5.9	18.2
Bog (LSB)	34.0	3.2	37.2	226.8	264.0
Herbaceous Wetlands	7.7	0	7.7	58.8	66.6
Ponds	0.4	0	0.4	1.4	1.8
Lakes	0	0	0	0.4	0.4
Rivers	2.2	0.1	2.3	34.7	37.0
Intermittent Streams (miles)	0.0	NE	0.0	7.8	7.8
Perennial Streams (miles)	0.0	NE	0.0	13.3	13.3
Uplands	119.4	72.9	192.3	3,753.4	3,945.6
Area (acre)	225.1	196.4	421.5	6,129.3	6,550.8
Wetland Area (acre)	103.1	123.4	226.5	2,339.5	2,566.0

Notes:

1 Construction impacts were based on an 18-mile, 100 foot wide construction right-of-way (ROW) from the operations facility at Tyonek to MP 0 of the Alternative 2 pipeline; wetlands and vegetation based on desktop photo-delineations that were not field verified.

2 This alternative would include 3 additional airstrips: Tatlawiksuk Airstrip (75% mapped for wetlands), Puntilla Airstrip (100% mapped for wetlands), and George River Airstrip (NWI indicates this is an upland site).

3 See Figure 3.11-24 for illustration of HGM classes.

NA = Not Applicable 0 = None 0.0 = < 0.1 ESB – SB = Ericaceous Shrub Bog – String Bog LSB = Low Shrub Bog

Source: 3PPI et al. 2014, FWS 2014a.

During operations, all access improvements (roads and airstrips) would be maintained for spill response for the diesel pipeline rather than most being removed and reclaimed after construction is completed in the case of the natural gas pipeline. Periodic vegetation maintenance would be required to prevent trees and large shrubs from growing within the maintained pipeline ROW as described for Alternative 2. The pipeline would operate at ambient temperatures and would be unlikely to increase or decrease soil temperatures as it crosses into and out of permafrost soils. Termination of the diesel pipeline would presumably be similar to Alternative 2 with any above ground facilities removed and the pipeline left buried in place. There would be an additional effort to flush any remaining diesel fuel from the pipeline prior to abandonment, which could lead to an increased potential for spills during termination over the natural gas pipeline.

Wetland functional assessment data are available for an additional 123 acres of wetlands impacted by portions of the additional airstrips; no functional assessment data were available for the additional 103 acres of wetlands impacted by the 18-mile extension of the diesel pipeline from the Tyonek dock (3PPI 2014b). Operations impacts from the diesel pipeline on wetlands would include retention of all airstrips and access roads for spill response and the 50-foot or 51-foot operational ROW (Table 3.11-45).

Table 3.11-45: Alternative 3B Diesel Pipeline Preliminary Calculation of Wetland Direct Impacts from Operations and Maintenance by Preliminary Wetland Function Ratings

Wetland Function Models	FCI Model Rating	Impact Area[1] (acres)	Study Area[2] (acres)	Area[3] (%)	Impact Criteria (Magnitude)
Hydrologic Functions					
Modification of Groundwater Discharge	Low	37.9	811.1	5%	Medium
	Mod	1,007.9	41,233.1	2%	Low
Modification of Groundwater Discharge	High	127.2	3,260.6	4%	Low
Modification of Groundwater Recharge	Low	0	8.1	0%	Low
	Mod	651.7	22,820.7	3%	Low
	High	105.7	4,935.6	2%	Low
Storm and Floodwater Storage	Low	0.0	10.0	0%	Low
	Mod	208.1	7,349.3	3%	Low
	High	964.9	37,974.1	3%	Low
Modification of Stream Flow	Low	199.8	20,752.9	1%	Low
	Mod	141.4	3,723.7	4%	Low
	High	76.0	2,249.5	3%	Low
Biogeochemical Functions					
Modification of Water Quality	Low	0.3	67.9	1%	Low
	Mod	8.3	621.7	1%	Low
	High	1,164.4	44,643.7	3%	Low

Table 3.11-45: Alternative 3B Diesel Pipeline Preliminary Calculation of Wetland Direct Impacts from Operations and Maintenance by Preliminary Wetland Function Ratings

Wetland Function Models	FCI Model Rating	Impact Area[1] (acres)	Study Area[2] (acres)	Area[3] (%)	Impact Criteria (Magnitude)
Export of Detritus	Low	161.8	14,842.8	1%	Low
	Mod	33.7	4,114.4	1%	Low
	High	263.4	8,611.9	3%	Low
Biological Functions					
Abundance and Diversity of Wetland Flora	Low	0.5	19.1	3%	Low
	Mod	22.1	965.8	2%	Low
	High	1,150.9	44,360.8	3%	Low
Abundance and Diversity of Wetland Fauna	Low	0.5	12.4	4%	NA
	Mod	380.4	18,861.0	2%	Low
	High	792.6	26,472.3	3%	Low

Notes:

1 Total reflects Alternative 2 pipeline operations impacts and 103 acres of additional airstrip impacts with functional assessment data, does not include first 18-miles of pipeline because wetland functional assessment data was not available (3PPI 2014b).
2 Totals reflect 81% of pipeline wetland study area included in the wetland functional assessment (3PPI 2014b).
3 Proportion of potential impact area within the pipeline wetland study area rated for wetland functions by FCI rating (Low > 0 and < 0.33; Moderate (Mod) ≥ 0.33 and < 0.66; High ≥ 0.66). Note that mosaic classes calculated as 100% wetlands overestimates the wetland area proportion.

0 = None
0.0 = < 0.1

Source: 3PPI 2014b.

Summary of Impacts for Alternative 3B

The overall impact of the mine site on wetlands would be moderate for both Alternative 3B and Alternative 2, as described for Alternative 2 (Table 3.11-46). The overall impact of the construction and operations of transportation facilities for Alternative 3B would be similar to Alternative 2; with an elimination of indirect effects from port expansions at Dutch Harbor and Bethel, diesel storage at Angyaruaq (Jungjuk) Port, and addition of a new dock extension and diesel storage facility at Tyonek. Some wetland impacts would be permanent; for example, the road and airstrip would be retained for access post-closure for monitoring. Elimination of fuel barges under Alternative 3B may reduce wetland erosion rates from barge wake energy to a low intensity with an increase of 1 to 3 percent. Barge activities on the Kuskokwim River and fuel shipments to Cook Inlet would be regional in extent and could affect wetlands that are important for supporting anadromous fish streams and subsistence resources. Most barge-related effects on wetlands would be short-term and the overall effects on wetlands for Alternative 3B would be considered minor.

Alternative 3B pipeline construction impacts on wetlands would be medium in intensity similar to Alternative 2, although impacts would be increased by 227 acres of primarily deciduous scrub shrub wetlands (62 percent); in addition, the dock at Tyonek would also impact a small area of estuarine wetlands and waters. Alternative 3B diesel pipeline operations effects on wetlands would be similar to Alternative 2, and would be low in intensity. The diesel pipeline wetland impact duration, extent, and context would be similar to the Alternative 2 natural gas pipeline, although areas for access roads and airstrips would not be reclaimed prior to termination of pipeline operations. Impacts associated with climate change would also be the same as those discussed for Alternative 2. The overall direct and indirect effects of the construction, operations, closure and reclamation of the diesel pipeline for Alternative 3B on wetlands would be moderate; the same as for Alternative 2.

Table 3.11-46: Summary of Impacts to Wetlands for Alternative 3B

Impacts	Impact Levels				
	Magnitude or Intensity	Duration	Geographic Extent	Context	Summary Impact Rating[1]
Mine Site					
Direct Wetland Impacts	Medium to High	Long-term	Local	Common to Important	Moderate
Potential Indirect Wetland Impacts	Medium	Long-term	Local	Common to Important	Moderate
Transportation Facilities					
Direct Wetland Impacts	Low	Long-term	Local	Common to Important	Minor
Potential Indirect Wetland Impacts	Low to Medium	Long-term	Local	Common to Important	Minor
Potential Barge Wake Erosion Impacts	Low	Short-term	Regional	Important	Minor
Pipeline					
Direct Construction Wetland Impacts	Medium	Short- to Long-term	Regional	Common to Important	Moderate
Direct Operations Wetland Impacts	Low	Long-term	Regional	Common to Important	Moderate

Notes:

1 The summary impact rating accounts for impact reducing design features proposed by Donlin Gold and Standard Permit Conditions and BMPs that would be required. It does not account for additional mitigation measures the Corps is considering.

Design features, Standard Permit Conditions and BMPs most important for reducing impacts to wetlands are described in Alternative 2. Additional mitigation and monitoring measures are also described in Alternative 2. If these mitigation measures were adopted and required, the summary impact rating would be the same as Alternative 2, primarily moderate.

3.11.4.5 ALTERNATIVE 4 – BIRCH TREE CROSSING (BTC) PORT

This alternative would move the port facility 69 miles downriver from Angyaruaq (Jungjuk) (Alternative 2) to BTC. This would reduce barge distances for freight and diesel but would increase the mine access road distance from 30 miles in Alternative 2, to 76 miles in Alternative 4.

3.11.4.5.1 MINE SITE– CONSTRUCTION; OPERATIONS AND MAINTENANCE; AND CLOSURE, RECLAMATION, AND MONITORING

The mine site activities and wetland impacts for Alternative 4 would be the same as Alternative 2.

3.11.4.5.2 TRANSPORTATION FACILITIES – CONSTRUCTION; OPERATIONS AND MAINTENANCE; AND CLOSURE, RECLAMATION, AND MONITORING

Transportation facilities would move the port site from Angyaruaq (Jungjuk) to BTC; the access road from the port site to the mine site would increase in length by 46 miles; and the airstrip and access road for the mine site would remain the same between Alternative 4 and Alternative 2. A temporary winter ice road from the vicinity of the Village of Crooked Creek to the mine site would be required to access material sites and begin construction of the BTC Road from the Donlin Gold mine site. Construction and operations at Bethel and Dutch Harbor Ports would be the same as for Alternative 2.

Construction of the BTC road, BTC port, and the mine airstrip and access road would disturb 1,120 acres of primarily flat HGM class wetlands (Table 3.11-47, Figure 3.11-31). Some of these impacts would be permanent as it is likely that the road and airstrip would remain to facilitate closure monitoring at the mine site.

Table 3.11-47: Alternative 4 Birch Tree Crossing Transportation Facility Preliminary Calculation of Wetland Direct Impacts from Construction, and Operations and Maintenance

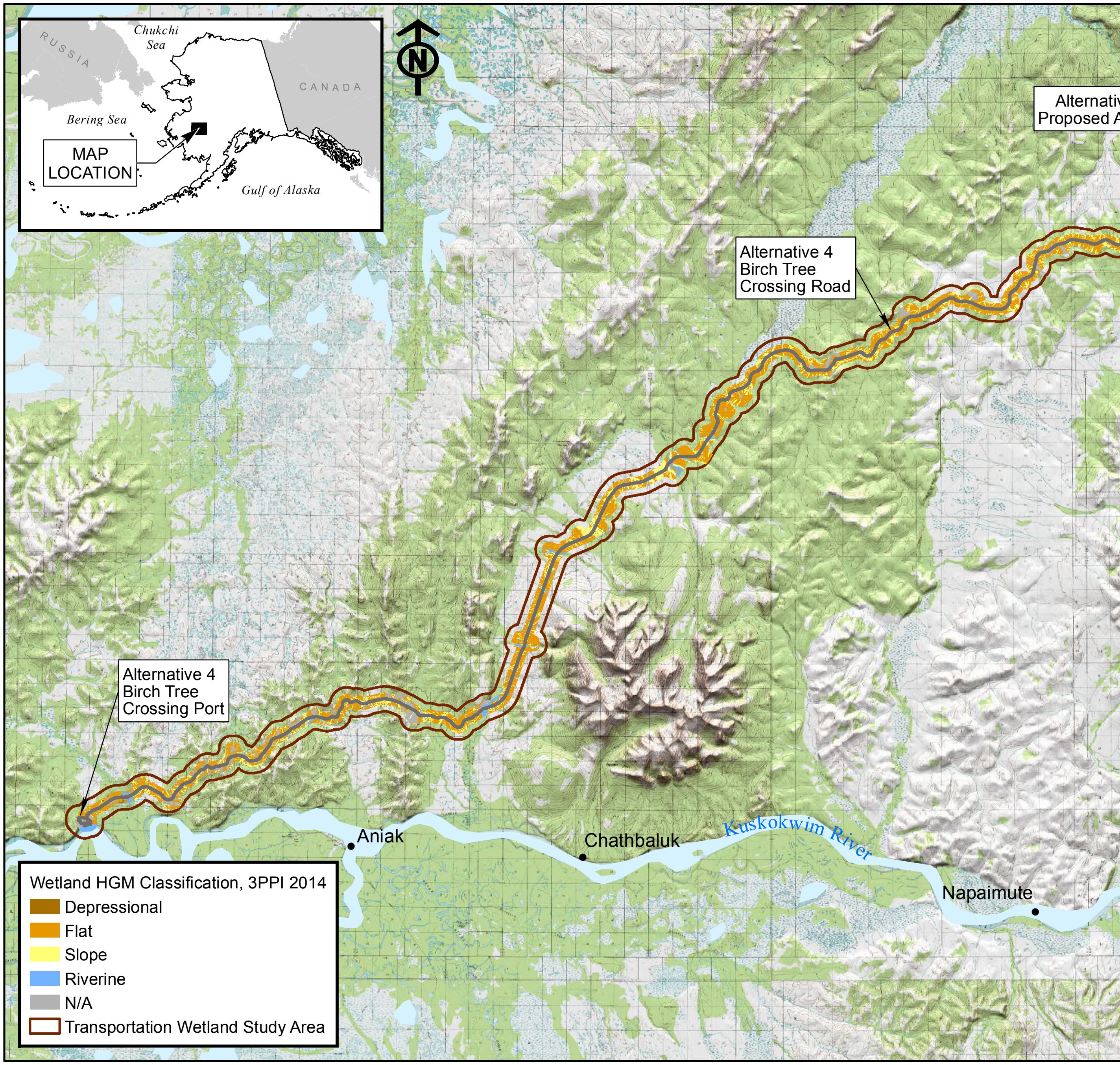
Wetland Category	HGM Class (acres)					Impact Area (acres)	Study Area (acres)	Area[1] (%)
	Depression	Flat	Slope	Riverine	River Channel			
Evergreen Forested Wetlands	0	367.9	25.4	9.2	0	402.5	19,663.3	2%
Deciduous Forested Wetlands	0	2.6	4.4	0.2	0	7.3	299.3	2%
Mixed Forested Wetlands	0	2.5	11.2	5.4	0	19.2	3,416.4	1%
Evergreen Scrub Shrub Wetlands	0	184.4	23.8	0.6	0	208.7	8,554.1	2%
Deciduous Scrub Shrub Wetlands	0.1	314.6	35.6	13.3	0	363.7	9,068.2	4%
Herbaceous Wetlands	0.7	99.7	16.8	1.6	0	118.7	3,855.8	3%
Ponds	0.0	0	0	0	0	0.0	52.0	0%
Rivers	0	0	0	0	11.4	11.4	644.4	2%
Intermittent Streams (miles)	NA	NA	NA	NA	NA	0.9	30.7	3%
Perennial Streams (miles)	NA	NA	NA	NA	NA	2.5	263.5	1%
Uplands	NA	NA	NA	NA	NA	574.9	8,992.9	6%
Area (acre)	0.8	971.7	117.3	30.3	11.4	1,706.4	54,546.4	3%
Wetland Area (%, acre)	<1%	86%	10%	3%	1%	1,120.2	44,857.1	2%

Notes:

1 Proportion of impact area in mine transportation wetland study area by wetland category. Note that mosaic classes calculated as 100% wetlands overestimates the wetland area.

NA = Not Applicable 0 = None 0.0 = < 0.1

Source: 3PPI et al. 2014.



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ALTERNATIVE 4
BIRCH TREE CROSSING
WETLAND IMPACTS

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FIGURE 3.11-31

Roads and dust generated by traffic can change soil pH and bulk density and cause drifting and dust deposition on snow that result in early spring melt and deeper active layers in areas with permafrost (Auerbach et al. 1997). Over half (52 percent) of the 1,120 acres of wetlands impacted by road construction and materials sites are likely supported by permafrost based on reconnaissance surveys and road borings summarized by RECON (2007a, 2007c and DMA 2007a). These wetlands are primarily flat (86 percent) and slope (10 percent) HGM classes with black spruce forested and scrub shrub (55 percent), deciduous scrub shrub (32 percent), and herbaceous (11 percent) wetlands. Geotextile and road fill would be used to insulate the permafrost and prevent thermokarst. Dust deposition likely would be heaviest within about 33 feet (10 meters) of the most heavily trafficked road, the BTC Road, but may influence vegetation and soils within about 328 feet (100 meters) (Auerbach et al. 1997; Ford and Hasselbach 2001; Hasselbach et al. 2005). Water trucks would be used to reduce dust from traffic on the road, and culverts would be placed to maintain hydrologic connections. Indirect effects from the BTC Road could result in some degradation or alteration of an estimated 4,692 acres of wetlands (Table 3.11-48).

Table 3.11-48: Alternative 4 Birch Tree Crossing Road Preliminary Calculation of Wetland Potential Indirect Impacts

Wetland Category	HGM Class (acres)					Impact Area[1] (acres)	Study Area (acres)	Area[2] (%)
	Depression	Flat	Slope	Riverine	River Channel			
Evergreen Forested Wetlands	0	1,522.0	160.4	12.9	0	1,695.3	19,663.3	9%
Deciduous Forested Wetlands	0	4.2	13.1	1.1	0	18.4	299.3	6%
Mixed Forested Wetlands	0	11.8	83.8	43.7	0	139.3	3,416.4	4%
Evergreen Scrub Shrub Wetlands	0	794.0	154.4	3.4	0	951.8	8,554.1	11%
Deciduous Scrub Shrub Wetlands	1.8	861.1	189.9	59.2	0	1,112.0	9,068.2	12%
Herbaceous Wetlands	11.4	596.8	149.9	17.2	0	775.4	3,855.8	20%
Ponds	0.8	0	0	0.4	0	1.2	52.0	2%
Rivers	0	0	0	0	8.7	8.7	644.4	1%
Intermittent Streams (miles)	NA	NA	NA	NA	NA	1.6	30.7	5%
Perennial Streams (miles)	NA	NA	NA	NA	NA	15.0	263.5	6%
Uplands	NA	NA	NA	NA	NA	1,035.2	8,992.9	12%
Area (acre)	14.0	3,790.0	751.5	137.9	8.7	5,737.3	54,546.4	11%
Wetland Area (%, acre)	<1%	81%	16%	3%	<1%	4,692.2	44,857.1	10%

Notes:

1 Indirect impact area from dust within 328 feet (100 meter) around Birch Tree Crossing road; material sites, and road footprint excluded.
2 Proportion of impact area in mine transportation wetland study area by wetland category. Note that mosaic classes calculated as 100% wetlands overestimates the wetland area.

NA = Not Applicable 0 = None 0.0 = < 0.1

Source: 3PPI et al. 2014.

Construction of the Crooked Creek winter trail for building the BTC Road would result in temporary impacts to waters and herbaceous wetlands and long-term to permanent impacts to scrub shrub and forested wetlands (Table 3.11-49). Winter trail construction would likely require some clearing and compaction which may result in conversion of scrub shrub and forested wetlands to herbaceous wetlands. Any areas with soil disturbance would be revegetated as required. Converted wetlands would be expected to eventually transition back to scrub shrub or forested wetlands over periods of several years to decades.

Table 3.11-49: Alternative 4 Preliminary Calculation of Wetland Direct Impacts from Crooked Creek Winter Trail Construction

Wetland Category	HGM Class (acres)					Impact Area (acres)	Study Area (acres)	Area[1] (%)
	Depression	Flat	Slope	Riverine	River Channel			
Evergreen Forested Wetlands	0	4.7	4.1	0.5	0	9.3	19,663.3	<1%
Deciduous Forested Wetlands	0	0	0	1.0	0	1.0	299.3	<1%
Mixed Forested Wetlands	0	0	0.3	3.4	0	3.7	3,416.4	<1%
Evergreen Scrub Shrub Wetlands	0.3	13.1	7.4	0.0	0	20.8	8,554.1	<1%
Deciduous Scrub Shrub Wetlands	0.1	12.5	26.9	3.6	0	43.0	9,068.2	<1%
Herbaceous Wetlands	0.9	0.6	4.2	0.5	0	6.1	3,855.8	<1%
Ponds	0.1	0	0	0	0	0.1	52.0	<1%
Rivers	0	0	0	0	0.7	0.7	644.4	<1%
Intermittent Streams (miles)	NA	NA	NA	NA	NA	0.1	30.7	<1%
Perennial Streams (miles)	NA	NA	NA	NA	NA	0.4	263.5	<1%
Uplands	NA	NA	NA	NA	NA	0.1	8,992.9	<1%
Area (acre)	1.4	30.8	42.8	9.1	0.7	84.9	54,546.4	<1%
Wetland Area (%, acre)	2%	36%	51%	11%	1%	83.9	44,857.1	<1%

Notes:

1 Proportion of impact area in mine transportation wetland study area by wetland category. Note that mosaic classes calculated as 100% wetlands overestimates the wetland area.

NA = Not Applicable
0 = None
0.0 = < 0.1

Source: 3PPI et al. 2014.

No facilities would be constructed along the barge route through the Kuskokwim River study area. Barge traffic would be the same level as Alternative 2, but the stretch of the river traveled by barges would be shortened by 69 river miles eliminating potential for wake-energy induced increases in wetland erosion rates of 0.01 acre/mile/year for this segment from Aniak to Napaimute in Alternative 2 (Table 3.11-28). The shortened route would also reduce the potential for grounding and fuel or chemical spills upriver from the BTC Port.

Closure, Reclamation, and Monitoring

The BTC port facilities would be removed and the site would be reclaimed similar to the Angyaruaq (Jungjuk) port facilities, but the BTC Road and the airstrip would remain to facilitate access to the site for post-closure monitoring. Reclamation of the port facility would include removal of all facilities, sheet piles, foundations, and drainage control structures. The port area would be regraded to approximate original contours or acceptable slopes, decompacted, covered with growth media if necessary, and seeded to promote vegetative growth. Most flat to gently sloping wetlands would be reclaimed by removal of fill. Fill would not likely be removed in areas where marginal hydrology of wetlands or upland mosaics with wetland inclusions makes restoration of wetlands not feasible.

3.11.4.5.3 PIPELINE – CONSTRUCTION; OPERATIONS AND MAINTENANCE; AND CLOSURE, RECLAMATION, AND MONITORING

The natural gas pipeline under Alternative 4 would be identical to Alternative 2.

3.11.4.5.4 SUMMARY OF IMPACTS FOR ALTERNATIVE 4

Alternative 4 mine site and pipeline construction and operations would be the same as Alternative 2. Potential Alternative 4 transportation facility construction and operations direct effects on wetlands would be low in intensity with a 2 percent reduction in wetland abundance within the study area. Potential indirect effects from dust and altered hydrologic conditions may be medium in intensity. Most effects would be long-term to permanent because the road and airstrip would not be reclaimed. Some wetlands and their associated functions may be reestablished at the port site at mine closure. The geographic extent of effects would be regional (affecting wetlands in the vicinity of the road, ice road, airstrip, and barge route across multiple watersheds). Many impacts (55 percent) would be to black spruce dominated wetlands (evergreen forested and scrub shrub wetlands) that are common throughout the region, although some impacts would be to higher value riparian wetlands. Impacts associated with climate change would also be the same as those discussed for Alternative 2. The overall direct and indirect effects of the construction and operations of Alternative 4 on wetlands would be considered moderate (Table 3.11-50 and Table 3.11-51).

Table 3.11-50: Alternative 4 Birch Tree Crossing Summary of Preliminary Calculation of Wetland Direct and Indirect Impacts from Transportation Facilities

Wetland Category	Construction, and Operations and Maintenance Direct Impact Area[1] (acre)	Potential Indirect BTC Road Dust Impact Area[2] (acre)	Crooked Creek Winter Trail Direct Impact Area[3] (acre)
Evergreen Forested Wetlands	402.5	1,695.3	9.3
Deciduous Forested Wetlands	7.3	18.4	1.0
Mixed Forested Wetlands	19.2	139.3	3.7
Evergreen Scrub Shrub Wetlands	208.7	951.8	20.8
Deciduous Scrub Shrub Wetlands	363.7	1,112.0	43.0
Herbaceous Wetlands	118.7	775.4	6.1
Ponds	0.0	1.2	0.1
Rivers	11.4	8.7	0.7
Intermittent Streams (miles)	0.9	1.6	0.1
Perennial Streams (miles)	2.5	15.0	0.4
Wetland Area	1,120.2	4,692.2	83.9

Notes:

0.0 = < 0.1

1 Based on 55-foot wide road, material sites, airstrip, access roads, port site; see Table 3.11-47and Figure 3.11-31 for breakdown by HGM class.

2 Potential indirect impact area from dust based on 328-foot (100-meter) buffer of Birch Tree Crossing road; see Table 3.11-48and Figure 3.11-31 for breakdown by HGM class.

3 Crooked Creek winter trail impact area based on 50-foot wide trail with pullouts; Table 3.11-49and Figure 3.11-31 for breakdown by HGM class.

Source: 3PPI et al. 2014.

Table 3.11-51: Summary of Impacts to Wetlands for Alternative 4

Impacts	Impact Levels				
	Magnitude or Intensity	Duration	Geographic Extent	Context	Summary Impact Rating[1]
Mine Site					
Direct Wetland Impacts	Medium to High	Long-term	Local	Common to Important	Moderate
Potential Indirect Wetland Impacts	Medium	Long-term	Local	Common to Important	Moderate
Transportation Facilities					
Direct Wetland Impacts	Low	Long-term	Regional	Common to Important	Moderate

Table 3.11-51: Summary of Impacts to Wetlands for Alternative 4

Impacts	Impact Levels				
	Magnitude or Intensity	Duration	Geographic Extent	Context	Summary Impact Rating[1]
Potential Indirect Wetland Impacts	Medium	Long-term	Regional	Common to Important	Moderate
Potential Barge Wake Erosion Impacts	Low	Short-term	Regional	Important	Moderate
Pipeline					
Direct Construction Wetland Impacts	Medium	Short- to Long-term	Regional	Common to Important	Moderate
Direct Operations Wetland Impacts	Low	Long-term	Regional	Common to Important	Moderate

Notes:

1. The summary impact rating accounts for impact reducing design features proposed by Donlin Gold and Standard Permit Conditions and BMPs that would be required. It does not account for additional mitigation measures the Corps is considering.

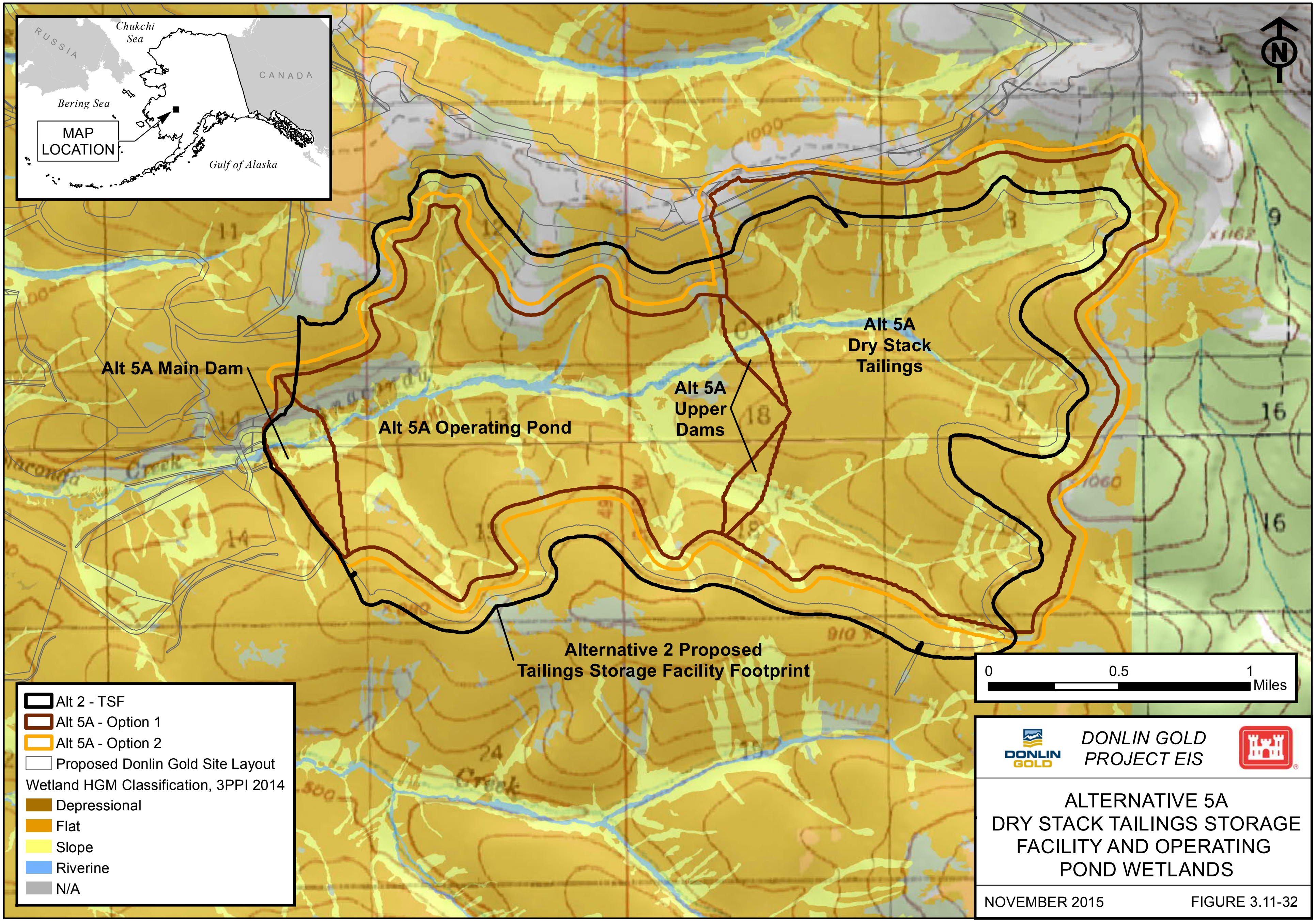
Design features, Standard Permit Conditions and BMPs most important for reducing impacts to wetlands are described in Alternative 2. Additional mitigation and monitoring measures are also described in Alternative 2. If these mitigation measures were adopted and required, the summary impact rating would be the same as Alternative 2, primarily moderate.

3.11.4.6 ALTERNATIVE 5A – DRY STACK TAILINGS

Alternative 5A evaluates alternate methods for handling tailings. Alternative 5A, Option 1 does not include a liner under the TSF, while Option 2 includes a full lining of the TSF. Both Options of Alternative 5A would use the same transportation and pipeline facilities as Alternative 2. For Alternative 5A Options the differences for direct wetland impacts would be limited to the footprint of the TSF (Figure 3.11-32).

3.11.4.6.1 MINE SITE – CONSTRUCTION; OPERATIONS AND MAINTENANCE; AND CLOSURE, RECLAMATION, AND MONITORING

Compared to Alternative 2, Alternative 5A Option 1 would directly affect an estimated 140 fewer acres of wetlands (Table 3.11-52). Effects on high functioning wetlands would appear to be variable, ranging from impacts affecting an additional 23 acres to impacts affecting 170 fewer acres of high functioning wetlands, depending on the function (Table 3.11-53). Alternative 5A Option 1 would appear to affect between 170 fewer acres and 17 additional acres of wetlands with high hydrologic functions; 135 fewer acres and 22 additional acres of wetlands with high biogeochemical functions; and 110 to 149 fewer acres of wetlands with high biological functions (Table 3.11-53).



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ALTERNATIVE 5A
DRY STACK TAILINGS STORAGE FACILITY AND OPERATING POND WETLANDS

NOVEMBER 2015

FIGURE 3.11-32

Compared to Alternative 2, Alternative 5A Option 2 would directly affect an estimated 94 more acres of wetlands (Table 3.11-52). Effects on high functioning wetlands would be variable, ranging from impacts affecting an additional 93 acres to no difference in impacts depending on the function (Table 3.11-53). Alternative 5A Option 2 would affect between 0 and 51 additional acres of wetlands with high hydrologic functions; 35 to 93 additional acres of high biogeochemical functions; and 27 to 77 additional acres of wetlands with high biological functions (Table 3.11-53).

Potential indirect effects from fugitive dust could be increased during operations under Alternative 5A compared to Alternative 2 because the tailings would be dewatered prior to transfer to the TSF. The upper and lower Contact Water ponds, and American and Snow Gulch reservoirs, would remain the same under both alternatives. At closure the pond and dam liners would be removed and the area would be reclaimed. Because the Operating Pond area for Alternative 5A Option 1 and 2 (about 40 percent of the TSF footprint) would not be filled with tailings, reclamation to previous contours, wetland types and function may be more successful. Overall, the effects of Alternative 5A Option 1 and 2 on wetlands would be similar to those of Alternative 2.

Table 3.11-52: Alternative 5A Tailings Storage Facility/Operating Pond Comparison of Preliminary Calculation of Wetland Direct Impacts

Wetland Category	Alternative 5A, Option 1 Dry Tailings[1] (acre)	Alternative 5A, Option 2 Dry Tailings[1] (acre)	Alternative 2 Wet Tailings[1] (acre)
Evergreen Forested Wetlands	1,808.2	1,978.2	1,842.0
Deciduous Forested Wetlands	0	0	0
Mixed Forested Wetlands	197.1	214.1	173.8
Evergreen Scrub Shrub Wetlands	252.8	293.5	378.7
Deciduous Scrub Shrub Wetlands	96.7	102.9	100.0
Herbaceous Wetlands	4.2	4.2	4.2
Ponds	0.3	0.3	0.3
Rivers	0.3	0.3	0.3
Wetland Area	2,359.0	2,592.9	2,498.6

Notes:

1 See Figure 3.11-32 for distribution of HGM classes within the TSF configurations for Alternative 5A, Option 1 and 2, and Alternative 2. Note that mosaic classes calculated as 100% wetlands overestimates the wetland area.

0 = None
0.0 = < 0.1

Source: 3PPI et al. 2014.

Table 3.11-53: Alternative 5A and Alternative 2 Tailings Storage/Operating Pond Comparison of Preliminary Calculation of Wetland Direct Impacts by Preliminary Wetland Function Ratings

Wetland Function Models[1]	FCI Model Rating	Alt 5A Impact Area (acres)		Alt 2 Impact Area[2] (acres)	Difference (acres)	
		Option 1	Option 2		Option 1	Option 2
Hydrologic Functions						
Modification of Groundwater Discharge	Low	16.1	24.5	30.1	-14.0	-5.6
	Mod	2,253.0	2,472.9	2,374.2	-121.2	98.7
	High	67.0	67.0	67.0	0.0	0.0
Modification of Groundwater Recharge	Low	0	0	0	0	0
	Mod	1,784.8	1,981.7	1,957.5	-172.7	24.2
	High	69.8	82.7	52.8	17.1	30.0
Storm and Floodwater Storage	Low	0	0	0	0	0
	Mod	200.0	212.7	177.3	22.7	35.4
	High	2,159.1	2,379.8	2,329.0	-169.9	50.8
Modification of Stream Flow	Low	469.7	534.9	475.6	-6.0	59.2
	Mod	185.6	198.3	163.0	22.6	35.3
	High	38.2	38.2	38.1	0.1	0.1
Biogeochemical Functions						
Modification of Water Quality	Low	22.9	28.1	35.0	-12.1	-6.9
	Mod	13.0	13.0	13.0	0.0	0.0
	High	2,323.1	2,551.4	2,458.3	-135.2	93.0
Export of Detritus	Low	428.7	489.9	425.1	3.6	64.8
	Mod	30.7	34.2	40.6	-9.9	-6.4
	High	216.4	229.1	193.7	22.7	35.4
Biological Functions						
Abundance and Diversity of Wetland Flora	Low	23.2	28.9	35.0	-11.8	-6.1
	Mod	179.4	181.8	165.2	14.2	16.5
	High	2,156.7	2,382.6	2,306.1	-149.4	76.5
Abundance and Diversity of Wetland Fauna	Low	23.2	28.9	35.0	-11.8	-6.1
	Mod	770.2	862.3	795.7	-25.5	66.5
	High	1,566.0	1,702.1	1,675.6	-109.7	26.5

Notes:

1 Functional Capacity Index (FCI) rating (Low > 0 and < 0.33; Moderate (Mod) ≥ 0.33 and < 0.66; High ≥ 0.66); waters including rivers, streams, and lakes were not assessed for wetland function (3PPI 2014b).

Alt = Alternative
0 = None
0.0 = < 0.1
Source: 3PPI 2014b.

3.11.4.6.2 SUMMARY OF IMPACTS FOR ALTERNATIVE 5A

Potential Alternative 5A mine site TSF/Operating Pond effects on wetlands would be high in intensity with an observable reduction in wetland abundance and alteration of function encompassing much of the local Anaconda Creek watershed. Effects would be long-term to permanent in duration during operations of the mine. Overall impacts to wetlands would be decreased by about 140 acres or increased by 94 during construction and operations for Alternative 5A Option 1 and 2, respectively, compared to Alternative 2. A primary difference between Alternative 5A with dry stack tailings and Alternative 2 with wet tailings may be in the potential for successful reestablishment of a larger area as wetlands after closure of the TSF/Operating Pond facilities. Reestablishment of wetlands within the operating pond area may be more successful for Alternative 5A because only process water and non-filterable tailings would be placed in the operating pond and original contours would not likely be substantially changed. Most impacts (87 to 88 percent) for Alternative 5A would be to black spruce dominated wetlands (evergreen forested and scrub shrub wetlands) that are common throughout the region. Impacts associated with climate change would also be the same as those discussed for Alternative 2. The overall direct and indirect effects of the construction, operations, closure, and reclamation of Alternatives 5A on wetlands would be considered moderate (Table 3.11-54).

Table 3.11-54: Summary of Impacts to Wetlands for Alternative 5A

Impacts	Impact Levels				
	Magnitude or Intensity	Duration	Geographic Extent	Context	Summary Impact Rating[1]
Mine Site					
Direct Wetland Impacts	Medium to High	Long-term	Local	Common to Important	Moderate
Potential Indirect Wetland Impacts	Medium	Long-term	Local	Common to Important	Moderate
Transportation Facilities					
Direct Wetland Impacts	Low	Long-term	Local	Common to Important	Minor
Potential Indirect Wetland Impacts	Low to Medium	Long-term	Local	Common to Important	Minor
Potential Barge Wake Erosion Impacts	Low to Medium	Medium-term	Regional	Important	Moderate
Pipeline					
Direct Construction Wetland Impacts	Medium	Short- to Long-term	Regional	Common to Important	Moderate
Direct Operations Wetland Impacts	Low	Long-term	Regional	Common to Important	Moderate

Notes:

1 The summary impact rating accounts for impact reducing design features proposed by Donlin Gold and Standard Permit Conditions and BMPs that would be required. It does not account for additional mitigation measures the Corps is considering.

Design features, Standard Permit Conditions and BMPs most important for reducing impacts to wetlands are described in Alternative 2. Additional mitigation and monitoring measures are also described in Alternative 2. If these mitigation measures were adopted and required, the summary impact rating would be the same as Alternative 2, primarily moderate.

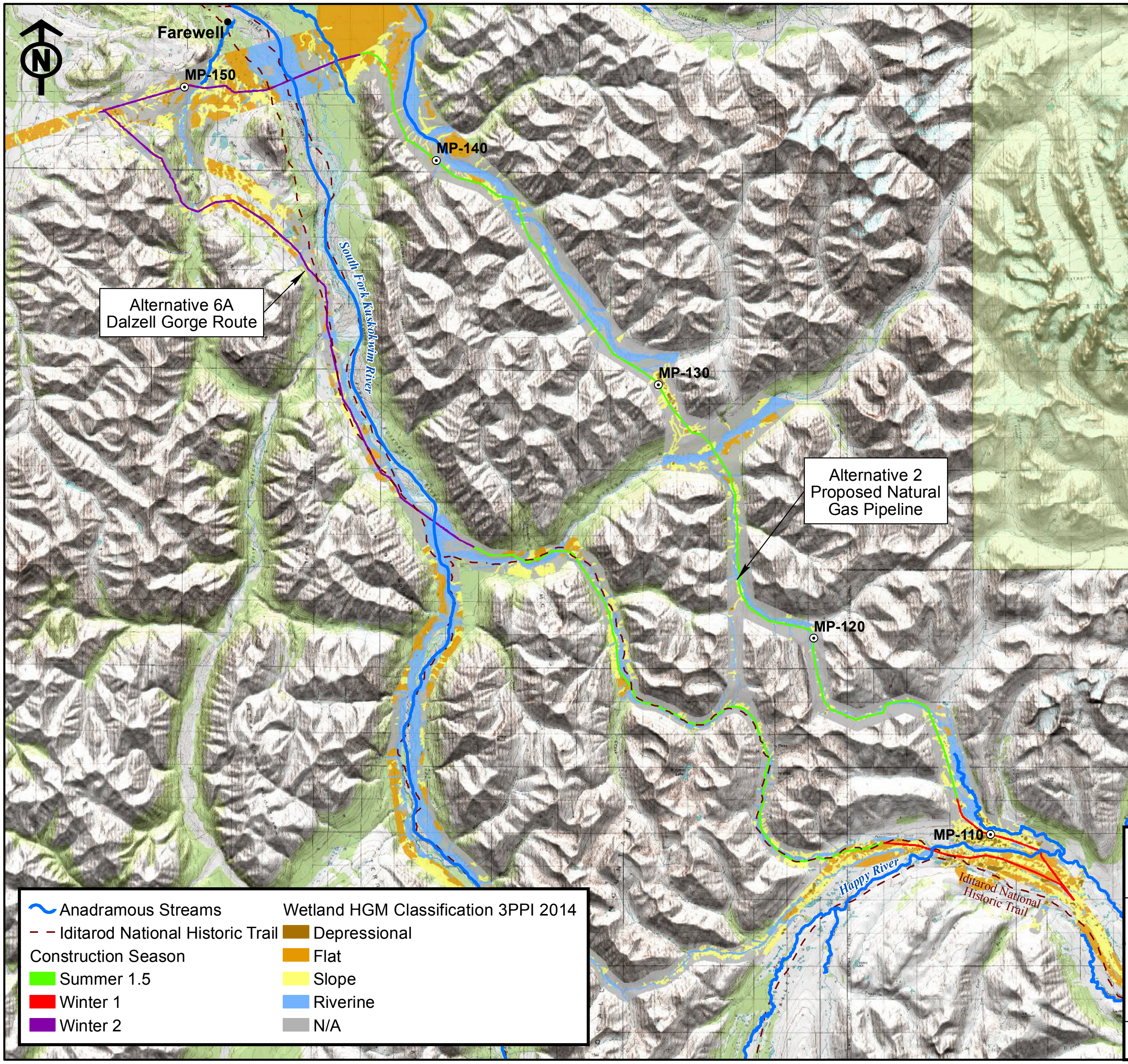
3.11.4.7 ALTERNATIVE 6A – MODIFIED NATURAL GAS PIPELINE ALIGNMENT: DALZELL GORGE ROUTE

Alternative 6A evaluates realignment for sections of the natural gas pipeline. Under Alternative 6A, mine site and transportation facilities would be the same as for Alternative 2.

3.11.4.7.1 PIPELINE – CONSTRUCTION; OPERATIONS AND MAINTENANCE; AND CLOSURE, RECLAMATION, AND MONITORING

The Dalzell Gorge Route alternative would re-route the 46.2-mile section of pipeline between MP 106.5 and MP 152.7 to the west through the Dalzell Gorge (Figure 3.11-33). The revised route would be 45.4 miles, or 0.8 mile shorter than the corresponding Alternative 2 route. Wetland mapping has been completed for both routes, although siting for camps, access roads, airstrips, and material sites was not available for evaluation. Direct construction-related impacts to wetlands within the 150-foot wide construction ROW for Alternative 6A would affect about 98 more acres of wetlands than the corresponding ROW segment of the route for Alternative 2 (Table 3.11-55). Most of the additional wetland area crossed by Alternative 6A (91 percent) would be constructed during winter (Figure 3.11-33). Alternative 6A construction would appear to affect an additional 71 acres of high storm and floodwater storage functioning wetlands and 95 additional acres of high modification of water quality functioning wetlands than the proposed Alternative 2 route (Table 3.11-56).

Operations and closure of the pipeline segment alternatives would be the same as described for Alternative 2. Permafrost distribution data for the Alternative 6A route indicates that 24 percent of the route crosses stable permafrost soils, and 8 percent crosses unstable permafrost soils. Wetlands on thaw unstable permafrost soils may be difficult to restore. Permafrost distribution data for the corresponding Alternative 2 route indicates that 11 percent of the route crosses stable permafrost soils, and 25 percent crosses unstable permafrost soils.



ALTERNATIVE 6A
DALZELL GORGE ROUTE
WETLAND COMPARISON

OCTOBER 2015

FIGURE 3.11-33

Table 3.11-55: Alternative 6A – Dalzell Gorge Route Pipeline Preliminary Calculation of Wetland Direct Impacts from Construction

Wetland Category	HGM[1] Class (acres)					Alt 6A Impact Area (acres)	Alt 2 Impact Area (acres)
	Depression	Flat	Slope	Lacustrine	Riverine		
Evergreen Forested Wetlands	0	25.7	36.1	0	4.0	65.7	56.0
Deciduous Forested Wetlands	0	0	0	0	0.3	0.3	0.1
Mixed Forested Wetlands	0	0	0.1	0	8.0	8.1	1.5
Evergreen Scrub Shrub Wetlands	0	5.2	28.6	0	1.4	35.3	19.8
Deciduous Scrub Shrub Wetlands	0.8	76.7	94.9	0.0	38.5	211.0	148.5
Bog (LSB)	0.3	5.5	20.2	0	0	25.9	3.8
Herbaceous Wetlands	0.8	0	10.3	0.1	4.1	15.3	11.7
Ponds	0.1	0	0	0	0.4	0.6	0.0
Lakes	0	0	0	0.0	0	0.0	0
Rivers	0	0	0	0	21.8	21.8	18.8
Intermittent Streams (miles)	NA	NA	NA	NA	NA	2.5	1.4
Perennial Streams (miles)	NA	NA	NA	NA	NA	2.4	1.1
Uplands	NA	NA	NA	NA	NA	463.2	580.3
Area (acre)	1.7	107.6	170.1	0.1	78.6	821.4	836.5
Wetland Area (%, acre)	<1%	30%	48%	<1%	22%	335.7	237.5

Notes:

1 Lacustrine contains both lacustrine and lacustrine fringe classes and riverine contains both riverine and river channel classes.

Alt = Alternative
NA = Not Applicable
0 = None
0.0 = < 0.1
LSB = Low Shrub Bog

Source: 3PPI et al 2014.

Table 3.11-56: Alternative 6A and Alternative 2 Pipelines Comparison of Preliminary Calculation of Wetland Direct Impacts from Construction by Preliminary Wetland Function Ratings

Wetland Function Models[1]	FCI Model Rating	Alt 6A Impact Area (acres)	Alt 2 Impact Area[2] (acres)	Difference (acres)
Hydrologic Functions				
Modification of Groundwater Discharge	Low	3.8	9.1	-5.3
	Mod	277.8	202.5	75.4
	High	54.6	25.9	28.7
Modification of Groundwater Recharge	Low	0	0	0
	Mod	73.5	64.5	9.0
	High	79.9	31.1	48.7
Storm and Floodwater Storage	Low	0	0	0
	Mod	79.7	51.5	28.2
	High	256.6	186.0	70.6
Modification of Stream Flow	Low	66.1	47.1	19.0
	Mod	41.6	32.3	9.3
	High	30.6	29.7	0.9
Biogeochemical Functions				
Modification of Water Quality	Low	0.4	0	0.4
	Mod	4.3	1.1	3.2
	High	331.6	236.4	95.2
Export of Detritus	Low	42.1	24.8	17.3
	Mod	12.7	17.0	-4.4
	High	107.4	71.4	36.0
Biological Functions				
Abundance and Diversity of Wetland Flora	Low	0	0	0
	Mod	1.1	6.1	-5.0
	High	335.2	231.4	103.8
Abundance and Diversity of Wetland Fauna	Low	0	0	0
	Mod	87.7	99.7	-12.0
	High	248.6	137.8	110.8

Notes:

1 Functional Capacity Index (FCI) rating (Low > 0 and < 0.33; Moderate (Mod) ≥ 0.33 and < 0.66; High ≥ 0.66); waters including rivers, streams, and lakes were not assessed for wetland function (3PPI 2014b).
2 Comparison Alternative 2 pipeline segment between MP 126.6 and 144.4.
Alt = Alternative
NA = Not Applicable
0 = None
0.0 = < 0.1

Source: 3PPI 2014b.

3.11.4.7.2 SUMMARY OF IMPACTS FOR ALTERNATIVE 6A

Potential Alternative 6 pipeline route variation construction and operations effects on wetlands would be medium in intensity with small reduction in wetland abundance or alteration of function along the routes (Table 3.11-57). Most construction-related effects would be temporary, as reclamation would begin soon after construction; however, because of the extended recovery time for boreal forest wetlands, effects may be long-term or permanent. Most wetlands would be restored, although functions would likely be reduced or altered for extended periods. A smaller proportion of unstable permafrost would be crossed by the Alternative 6A segment compared to the Alternative 2 segment. Wetlands on unstable permafrost soils may be difficult to restore as wetlands. Alternative 6A would potentially affect about 98 more acres of wetlands than the proposed Alternative 2 route segment. Impacts associated with climate change would also be the same as those discussed for Alternative 2. The overall direct and indirect effects of the construction, operations, closure, and reclamation of the natural gas pipeline route for Alternative 6A on wetlands would be considered moderate.

Table 3.11-57: Summary of Impacts to Wetlands for Alternative 6A

	Impact Levels				
Impacts	**Magnitude or Intensity**	**Duration**	**Geographic Extent**	**Context**	**Summary Impact Rating[1]**
Mine Site					
Direct Wetland Impacts	Medium to High	Long-term	Local	Common to Important	Moderate
Potential Indirect Wetland Impacts	Medium	Long-term	Local	Common to Important	Moderate
Transportation Facilities					
Direct Wetland Impacts	Low	Long-term	Local	Common to Important	Minor
Potential Indirect Wetland Impacts	Low to Medium	Long-term	Local	Common to Important	Minor
Potential Barge Wake Erosion Impacts	Low to Medium	Medium-term	Regional	Important	Moderate
Pipeline					
Direct Construction Wetland Impacts	Medium	Short- to Long-term	Regional	Common to Important	Moderate
Direct Operations Wetland Impacts	Low	Long-term	Regional	Common to Important	Moderate

Notes:

1 The summary impact rating accounts for impact reducing design features proposed by Donlin Gold and Standard Permit Conditions and BMPs that would be required. It does not account for additional mitigation measures the Corps is considering.

Design features, Standard Permit Conditions and BMPs most important for reducing impacts to wetlands are described in Alternative 2. Additional mitigation and monitoring measures are also described in Alternative 2. If these mitigation measures were adopted and required, the summary impact rating would be the same as Alternative 2, primarily moderate.

3.11.4.8 IMPACT COMPARISON – ALL ALTERNATIVES

Although there are differences among alternatives within the project components that would affect wetlands such as longer or shorter access road and pipeline, different operations at the mine site, and more or fewer barge trips, the summary impact levels are generally the same for the alternatives because the overall changes among the alternatives would result in relatively small changes compared to the overall impacts. Among the impact-causing components of the project, at least one component under each of the alternatives would cause moderate impacts. A quantitative comparison of the wetland impacts by alternative is presented in Table 3.11-58; shaded cells indicate differences from the proposed action (Alternative 2).

Table 3.11-58: Comparison of Impacts by Alternative*

Impact-Causing Project Component	Alternative 2 – Proposed Action	Alternative 3A – LNG-Powered Haul Trucks	Alternative 3B – Diesel Pipeline	Alternative 4 – BTC Port	Alternative 5A - Dry Stack Tailings	Alternative 6A – Dalzell Gorge Route
Mine Site – Direct Wetland Impacts	6,968.2 acres	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2	6,828.6 acres	Same as Alternative 2
Mine Site – Potential Dust Indirect Wetland Impacts	1,957.6 acres	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2	>1,957.6 acres	Same as Alternative 2
Mine Site – Potential Dewatering Indirect Wetland Impacts	553.2 acres	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2
Transportation Facilities – Direct Wetland Impacts	414.3 acres	Same as Alternative 2	Same as Alternative 2	1,131.6 acres	Same as Alternative 2	Same as Alternative 2
Transportation Facilities Potential Dust Indirect Wetland Impacts	1,740.4 acres	Same as Alternative 2	Same as Alternative 2	4,702.1 acres	Same as Alternative 2	Same as Alternative 2
Transportation – Potential Barge Wake Erosion	0.01 – 0.21 acres/mile/ year	0.01 – 0.12 acres/mile/ year	0.00 – 0.08 acres/mile/ year	0.03 – 0.08 acres/mile/year route would be 69 miles shorter	Same as Alternative 2	Same as Alternative 2
Pipeline –Construction Wetland Impacts	2,376.0 acres	Same as Alternative 2	2,605.2 acres	Same as Alternative 2	Same as Alternative 2	2,474.2 acres
Pipeline – Operations Wetland Impacts	1,069.8 acres	Same as Alternative 2	1,246.2 acres	Same as Alternative 2	Same as Alternative 2	1,102.5 acres
Total Direct Wetland Impacts[1]	**9,758.5 acres**	Same as Alternative 2	**9,987.7 acres**	**10,475.8 acres**	**9,618.9 acres**	**9,856.7 acres**
Potential Indirect Wetland Impacts[2]	**3,698.0 acres**	Same as Alternative 2	Same as Alternative 2	**6,659.7 acres**	**>3,698.0 acres**	Same as Alternative 2
Summary Impact Level	**Moderate**	**Moderate**	**Moderate**	**Moderate**	**Moderate**	**Moderate**

Notes:
Shaded cells indicate differences from the proposed action (Alternative 2).
* The No Action Alternative would have no new impacts.
1 Total includes only pipeline direct construction impacts; all pipeline operation wetland impacts areas are also included within construction impact areas.
2 Total includes only potential mine site and transportation facilities indirect impacts from dust; many of the mine site drawdown indirect impact areas would also be affected by dust generated at the mine site.

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